DOCUMENT RESUME

ED 227 287 CE 035 320

AUTHOR Spetz, Sally H.
TITLE Basic Mathematics. Apprentice Related Training Module.
INSTITUTION Conserva, Inc., Raleigh, N.C.
SPONS AGENCY Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE 82
CONTRACT 300-80-0937
NOTE 83p.; For related documents, see CE 035 315-335.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Apprenticeships; *Arithmetic; Career Education; *Decimal Fractions; Definitions; *Fractions; *Mathematical Formulas; Mathematics Skills; Postsecondary Education; Pretests Posttests; *Tables (Data)

ABSTRACT

One in a series of core instructional materials for apprentices to use during the first or second years of apprenticeship-related subjects training, this booklet deals with basic mathematics. The first section consists of an outline of the content and scope of the core materials as well as a self-assessment pretest. Covered in the three instructional chapters included in the booklet are arithmetic operations (characteristics of numbers and addition, subtraction, multiplication, and division); fractions (fractions as parts of a whole; adding, subtracting, multiplying, and dividing fractions; decimal fractions; adding, subtracting, multiplying, and dividing decimal fractions; and using percentages); and formulas and tables (writing formulas for rules and solving formulas for unknowns as well as reading tables). Each chapter contains an overview, a chapter example, and a self-test exercise. Appended to the booklet are answers to the self-assessment pretest, answers to the self-assessment exercises, a posttest, and answers to the posttest. (MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED227287

BASIC MATHEMATICS

Apprentice Related Training Module

Sally H. Spetz

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

1982
CONSERVA, Inc.
Raleigh, North Carolina

CE 035 320

Table of Contents

Glossary v

1. How To Use This Booklet

What Is This Series About? 1
What Is This Booklet About? 1
What Must I Do To Complete My Work In This Booklet? 2
How Much Do I Know About The Subject As I Begin? 2
Self-Assessment Pretest 3

2. Arithmetic Operations

Chapter Overview 6
Introduction And Objectives 6
Characteristics Of Numbers 7
  Whole Numbers 7
  Place Values 8
Addition 10
Subtraction 13
Multiplication 16
  Single-Digit Multiplication 17
  Multiple-Digit Multiplication 19
Division 21
  Single-Digit Division 21
  Multiple-Digit Division 23
Chapter Example 25
Self-Test Exercises 27

3. Fractions

Chapter Overview 30
Introduction And Objectives 30
Fractions As Parts Of A Whole 31
  Reducing Fractions 32
  Mixed Numbers 34
Addition With Fractions 36
  Adding Fractions With The Same Denominators 36
  Adding Fractions With Different Denominators 36
Subtraction With Fractions 39
Multiplication With Fractions 42
Division With Fractions 44
Decimal Fractions 46
  Changing Fractions To Decimals 47
  Rounding Decimals 48
Addition And Subtraction Using Decimals 50
Multiplying And Dividing With Decimals 51

Using Percents 54
Change Fractions To Percents 54
Calculate Percentage Of A Total Amount 56
Determine What Percent An Amount Is 57
Self-Test Exercises 58

4. Formulas And Tables

Chapter Overview 60
Introduction And Objectives 60
Writing Formulas For Rules 61
Solving Formulas For Unknowns 63
Reading Tables 65
Reading The Table Backwards 67
Other Table Formats 67
Self-Test Exercises 69

5. Appendix

Answers To Pretest 71
Answers To Self-Test Exercises 72
Posttest 74
Answers To Posttest 77

Glossary

The words, symbols and abbreviations on this list are used in this booklet. Please review the terms and become familiar with their definitions. The meaning of the words in the text may not be the form of the word with which you are familiar. Refer back to the glossary when needed as you work through the *Basic Mathematics* booklet.

Words/Terms

1. *Arithmetic Operations* A term which refers to the four operations: addition, subtraction, multiplication and division.
2. *Carry* To retain a portion of the results of a step in addition or multiplication and include it in the results from the next step. The term also refers to the number that is retained or "carried" to the next step.
3. *Common Factor* A number which divides into two or more other numbers with no remainders.
4. *Common Fraction* A fraction written as the number of parts (numerator) over the total parts in the whole (denominator), for example, $\frac{3}{4}$, $\frac{9}{10}$, or $\frac{9}{100}$.
5. *Decimal Fraction* A fraction with a denominator being a power of 10 (10, 100, 1000, and so on). Only the numerator is written, with the denominator indicated by the position of a decimal point, for example, .75, .9 or .09.
6. *Denominator* The part of a fraction that indicates the total parts in a whole. In the fraction, $\frac{3}{4}$, 4 is the denominator.
7. *Dividend* One of the parts in a division problem. This is the number divided *into*. In the problem, $24 \div 8$ or $8\overline{)24}$, *24* is the dividend.
8. *Divisor* One of the parts in a division problem. This is the number divided *by*. In the problem, $24 \div 8$ or $8\overline{)24}$, *8* is the divisor.
9. *Improper Fraction* A common fraction in which the numerator is larger than the denominator, for example, $\frac{13}{8}$.
10. *Intersect* To cross or meet.
11. *Invert* To turn a fraction upside-down, writing the denominator over the numerator.
12. *Lowest Common Denominator (LCD)* The smallest common factor that will divide evenly into the denominators of two or more fractions.
13. *Lowest Terms* A form of a fraction where the numerator and denominator have no common factor.
14. *Magnitude* An amount, size or extent.
15. *Mixed number* A number that contains a whole number and a fraction, for example $8\frac{1}{8}$.
16. *Multiplier* One of the parts of a multiplication problem, usually the smaller of two numbers being multiplied.
17. *Number Line* A line, somewhat like a ruler which shows the magnitudes and signs (negative or positive) of numbers on either side of a zero point.
18. *Numerator* The component of a fraction that tells how many parts of the whole are being dealt with in the fraction. In the fraction, $\frac{3}{4}$, *3* is the numerator.
19. *Place Holder* A function of zero, when it is used to indicate that a particular place value is empty. Zero as a place holder in the number 40,546 indicates that there are no one thousands.

20. *Place Value* The value of the location of a digit within a number.
21. *Proper Fraction* A fraction whose numerator is smaller than its denominator.
22. *Remainder* A part of a division problem that is the amount "left over" when the divisor does not divide evenly into the dividend.
23. *Whole Number* A common counting number that can have a + or − sign.

Signs/Symbols

+ A positive quantity. The symbol can also refer to the addition operation. Read as "plus."
− A negative quantity or the subtraction operation. Read as "minus."
× Indicates the multiplication operation. Read as "times."
÷ or)‾ Indicates the division operation. Read as "divided by" (÷) or "divides into" ()‾).
= An equal sign. Means that the quantity on the left of the sign is equivalent to the quantity on the right.
% A percent sign. A percent is a special fraction with a denominator of 100.
π The value, pi. A constant equal to approximately 3.14 that is used in computations dealing with circular figures.
° A sign used to mean degrees.
" A sign used to represent inches.
' A sign used to represent feet.

Abbreviations Used

cm centimeters (length measure)
ft feet (length measure)
in inches (length measure)
kwh kilowatt hours (measure of electricity usage)
lb pounds (weight measure)
mm millimeters (length measure)
oz ounces (weight measure)

1. How To Use This Booklet

What Is This Series About?

Basic Mathematics is one of ten booklets written as core instructional materials for apprentices to use during the first or second years of apprenticeship related subjects training. Nine of the booklets are about critical subject areas for apprentices, as determined by a national group of experts on apprenticeship and training. The tenth booklet introduces the other booklets and explains how to use the materials in the instructional setting.

The materials are designed to be used with other related subjects instructional materials. They can be employed in one of two ways: (1) the materials can be used as the total instructional materials package for some trades, in subjects such as basic science, measurement, and working in organizations; or (2) they can be used as supplementary, introductory or practice materials in subjects such as basic mathematics, safety and an introduction to apprenticeship.

The booklets are written in a self-instructional, self-paced format. They can be used either in instructor supervised or independent study arrangements. *Each booklet and each chapter is written as a distinct unit and is addressed to a single major topic.* This means that you or your instructor can select individual booklets or chapters without necessarily using every booklet or every chapter within a booklet.

The booklets emphasize application of facts, concepts and skills. Material is presented by means of written information, visual illustration and applied example. The discussion for most major topics also includes an application section that requires you as a learner to demonstrate what you are learning. In addition, each chapter contains a section entitled Self-Test Exercises that contains questions, problems and exercises for you to work through as a final application of the knowledge or skill and to show that you have mastered the materials.

The titles of the booklets in the core materials are:

1. *A Basic Core Curriculum*
2. *Introduction to Apprenticeship*
3. *Basic Mathematics*
4. *Basic Safety I*
5. *Basic Safety II*
6. *Basic Measurement*
7. *Sketching, Drawing and Blueprint Reading*
8. *Basic Physical Science*
9. *Working in Organizations*
10. *Interpersonal Skills and Communications*

What Is This Booklet About?

Mathematics is a vital part of people's daily activities. To an apprentice, journeyman or master craftsperson, mathematics is particularly important to completing many work tasks. This

booklet deals with mathematics as it is used in a variety of apprenticeable occupations. Practical problems illustrate each of the topics covered by the materials. Specific topics included are the following:

1. The four basic arithmetic operations (addition, subtraction, multiplication and division)
2. Use of fractions, decimals and percents
3. Use of formulas and tables

What Must I Do To Complete My Work In This Booklet?

Working your way through this booklet will require you to read the text, to answer the questions, to perform the exercises and to complete the pretest and posttest instruments. Expect to spend about five hours working through the materials. The only resources you need to complete your work in this booklet are: (1) a copy of the booklet; (2) a pencil or pen; (3) a ruler; and (4) about five hours of time.

The materials are written in a self-instructional, programmed format. You may work through the text, examples, and questions at your own pace and leisure. You need not complete your work in the booklet at one sitting.

Each chapter in the booklet is devoted to a single skill, competency or unit of knowledge. The general format of the chapters is similar, with the following parts:

1. A *chapter overview* containing all the necessary information you need to know in order to work through the chapter.
2. An *introduction* describing the knowledge or skill and the instructional objectives for the information.
3. *Principles, examples* and *applications* presenting and explaining the content as well as offering you practice opportunities to apply the information.
4. Additional sources of *information.*
5. *Self-test exercises* for applying the information under consideration.

This booklet concludes with an Appendix that contains the answers to the Pretest, the Self-Test exercises from each chapter and the Posttest.

How Much Do I Know About the Subject As I Begin?

Begin your work in *Basic Mathematics* by completing the self-assessment pretest that follows. When you have completed the pretest as directed in the assessment instructions and have finished reading the other materials in this introductory section, continue your work in this booklet, one chapter at a time. Begin with Chapter 2 unless the results of your self-assessment indicate that you should do otherwise.

In each chapter, do the following:

1. Read:
   - Background information
   - Steps and procedures for performing skilled activities and explanations of major points and ideas
   - Examples illustrating use of information, performance or skill, or application of material
2. Consider the questions and exercises in the text. Work the questions and check your answers.
3. When you believe that you have mastered the material, take the Self-Test at the end of the chapter.
4. Check your answers with those provided in the Appendix at the end of the booklet. If you achieve at least the minimum acceptable score, move to the next chapter. If your score is below acceptable levels, work through the chapter again.
5. After completing all the chapters, take the Posttest at the back of the booklet. Check yourself with the answers provided to see if you have mastered *Basic Mathematics.*

Self-Assessment Pretest

Directions: *The self-assessment will help you focus on specific strengths and limitations of your mathematics knowledge and skills. Select or calculate the best answer for each question and record it in the appropriate space. After you have worked through the entire pretest, score your test following the directions at the bottom of the test.*

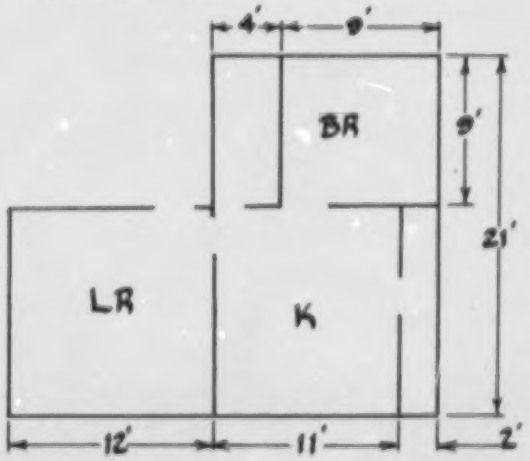
1. An electric meter reads 14725 KWH. What are the place values for each of the digits in the reading:

Digit	*Place Value*
1:	
4:	
7:	
2:	
5:	

2. The meter reading in question #1 was taken in March. If 839 KWH were used in the next month, what would the reading in April be?

3. If the same number of KWH were used in each month, what would be the meter reading next March (after 12 months)?

4. What is the length of the house in the figure below?



5. What is the width of the living room?

6. Metal rods measuring 156" are to be cut into 6" lengths. How many rods would be needed to cut 104 of the 6" lengths?

7. A plumber has $458 in a checking account. If the plumber pays a $165 electric bill, how much would be left in the account?

8. A paperer has 18 rolls of wall paper on hand. If each roll covers 128 square feet, how many total square feet of wall can be covered with the paper on hand?

9. A machinist calculated a desired dimension to be 35.36864 mm. Round this measurement to the nearest thousandth mm.

10. Four parts of a component weighed as follows:
    6 ⅞ oz
    1 ⅜ oz
    4 ½ oz
    3 ¾ oz
    What is the total weight of the component? Reduce your answer to lowest terms.

11. Each adjustment on a 6 ¾" circumference control moves the knob ⅜". How many adjustments are required to move the knob one complete turn?

12. Parts which generally sold for $154.00/1,000 were being offered at a 25% discount. What is the disount price for 1000?

13. What would be the savings on an order of 8000 parts from Question 12?

14. A metal plate measured 5-⅝". Convert this to a decimal.

15. A part is to be increased in size by ¼. What is the increased value for a dimension which measures 3-⅜"?

16. A rod measures 15-⅛ inches in length. If a work order requires a rod 14.25" in length, how much needs to be cut off? Express your answer as a common fraction.

17. Write the following statement as a formula: The distance travelled by an object is equal to its velocity multiplied by the time travelled.

18. Write the following relationship as a formula: Perimeter of a rectangle is computed as the product of 2 times its length plus 2 times its width.

19. R = E/I. If the voltage (E) in a system is 220 and amperage (I) is 40, what is the resistance (R)?

20. Using the following formulas, calculate the area of a circle with a 7-½" diameter (D):
    $A = \pi \times R \times R$
    $R = D/2$
    $\pi = 3.14$

21. Convert 25° Celsius to Fahrenheit using the table below.

°F	°C
70	21
72	22
74	23
76	24
77	25
79	26
81	27
83	28

22. **The table below shows average monthly flow of waste from three sites into the City River for a six-month period. During which month did Site B have its greatest flow?**

Average Monthly Flow of Waste (liters/meter)

Month	Site		
	A	B	C
Jan	249	382	419
Feb	381	392	379
March	407	357	298
April	352	372	305
May	312	398	317
June	319	337	302

Scoring: *Check your answers with those provided in the Appendix. Mark each answer right or wrong. Then, grouping the answers into the sets of questions listed below, count the number correct for each set. Enter the amount in the appropriate spot on the Chapter Overview Chart that introduces each chapter, beginning with Chapter 2.*

Questions 1-8, number correct is _____.
Questions 9-16, number correct is _____.
Questions 17-22, number correct is _____.

2. Arithmetic Operations

Chapter Overview

Purpose:	To develop skills in basic arithmetic operations as applied to the trades. An apprentice will gain an understanding of how numbers are used to perform operations and an ability to solve work-related arithmetic problems.
Preassessment Score:	Write in the following space the number of correct answers from Pretest questions 1-8: _____ If you answered seven or eight questions correctly, skip to Chapter 3. If you missed two or more questions, work through this chapter.
Prerequisites:	Chapter 1 of this booklet. Mastery of addition, subtraction, multiplication and division of one-digit numbers.
Resources:	Time—about 2-3 hours to complete. You do not need to work through the chapter in one sitting. Materials—paper, pencil.
Performance Measure:	A thirty-minute paper-and-pencil Posttest, to be taken after completing the entire booklet.
Standards:	To be successful, you must answer correctly 80% of the Posttest items.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-Test Exercises and the Posttest.

Introduction and Objectives

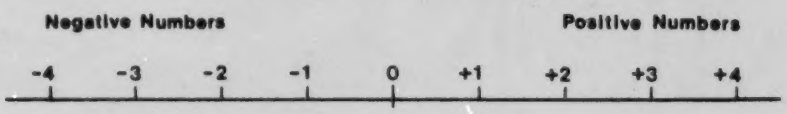
Four basic arithmetic operations form the foundation for much of mathematics: addition, subtraction, multiplication and division. These operations are involved in many of our everyday life activities, such as keeping a checkbook balance, comparative shopping, splitting a lunch tab or figuring your taxes. Moreover, they are extremely important because they are used in mathematical applications in virtually every apprenticeable trade. Applications range from calculating the pitch of a screw thread to determining the resistance of an auto starting motor to doubling the ingredients in a recipe. In each case, the fundamental arithmetic operations are critical to performing the task at hand. Thus, you should pay particular attention to this unit, either as a refresher for what you have learned before or a new way of looking at things you have had difficulty with in the past. After you have completed your work in this chapter, you will demonstrate your ability to:

1. Relate how characteristics of numbers are used to perform operations.
2. Solve work-related problems requiring addition.
3. Solve work-related problems requiring subtraction.
4. Solve work-related problems requiring multiplication.
5. Solve work-related problems requiring division.

Characteristics of Numbers

Whole Numbers

The everyday numbers you use for such things as counting, telling time and measuring temperature are called *whole numbers*. Often whole numbers are portrayed on a number line, something like a ruler. Look at the number line in Figure 1. It is used to illustrate the following principles which are basic to mastering arithmetic operations.



The Number Line

Figure 1

1. *Positive numbers become greater as you move away from zero. Negative numbers are smaller as you move away from zero.*

   For example, if you are running a business and you are operating in the black (making a profit), you want your balance to be a large number. If you are in the red, or losing money, however, a small balance would be better. This is because it is a negative number, and the closer it is to zero the less you would be in debt.
2. *Except for their signs, positive numbers and negative numbers behave in the same way.*

   On the number line, two is twice as far away from zero as one. Thus, two is two times as large as one, whether positive or negative.

   Starting at +1 on the line, move two units to the right. You end up at 3. Stated differently, one unit plus two units equals three units. The same principle could be applied using negative numbers.

Example

A carpenter has one 8-foot two-by-four. He needs the following pieces:

Two 3-foot sections
One 4-foot section

He can use the number line to determine if he has enough lumber. He starts at +8 on the number line, which represents the total length of the lumber. He moves to the left 3 units for the first 3-foot section and ends on +5. He then moves to the left 3 more units for the second 3-foot section and ends on +2. For the 4-foot section he moves four more to the left and ends on −2. How many feet short is he? If he went out and bought a two-foot length of 2×4, would he have enough lumber? Why not?*

* *Answer*

Since the carpenter ended on −2 on the number line, he would be 2 feet short of lumber. If he bought a 2-foot section, he still would not have enough. He would have two 2-foot sections when he needs one 4-foot section.

Exercises

Use the number line to complete the following exercises as illustrated in a, b, and c.

	Start At	*Move*	*End At*	*Write the Operation*
a.	3	+4	7	3 + 4 = 7
b.	6	−3	3	6 − 3 = 3
c.	−2	−3	−5	−2 − 3 = −5
d.	2	+1		
e.	3	−2		
f.	8	9		
g.	−5	+2		
h.	−4	−1		

Answers

	Start At	*Move*	*End At*	*Write the Operation*
d.	2	+1	3	2 + 1 = 3
e.	3	−2	1	3 − 2 = 1
f.	8	−9	−1	8 − 9 = −1
g.	−5	+2	−3	−5 + 2 = −3
h.	−4	−1	−5	−4 − 1 = −5

Place Values

A place value is the value of the location of a digit within a number. To see this, look at the place values of the following number.

Billions	Hundred-millions	Ten-millions	Millions	Hundred-thousands	Ten-thousands	Thousands	Hundreds	Tens	Ones
4,	3	0	8,	4	4	4,	5	1	2

Each place value is ten times the value to its right. For example, one hundred is ten times ten. One thousand is ten times one hundred. The example number could be read: Four billion, three hundred eight million, four hundred forty-four thousand, five hundred twelve. Each of the place values by itself would look like this:

4 Billions:	4,000,000,000
3 Hundred-millions:	300,000,000
0 Ten-millions:	00,000,000
8 Millions:	8,000,000
4 Hundred-thousands:	400,000
4 Ten-thousands:	40,000
4 Thousands:	4,000
5 Hundreds:	500
1 Tens:	10
2 Ones:	2
Added up, the place values equal:	4,308,444,512

Zero is used as a *place holder*, for ten-millions in this example. Be sure to remember to include the zero place holder. If your supervisor told you to place an order for one hundred eight (108) square feet of corrugated iron, how big would your order be if you forgot the zero place holder?* You surely would not want a zero left out of your paycheck.

Exercises

Use the illustration of an electric meter in Figure 2 to answer the questions. To read the meter you read dials from left to right, writing down the numbers pointed to on each dial. Write the smaller number when the pointer is between two figures.

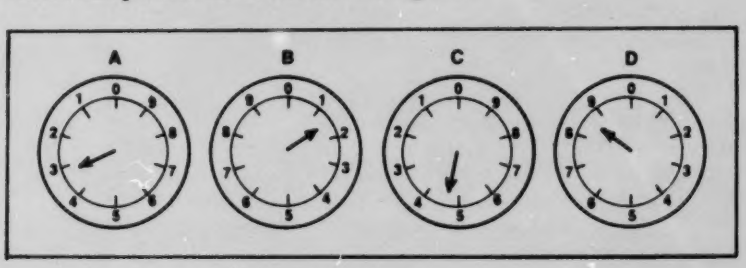


Figure 2

1. What is the reading on the meter? _____

2. Write the place value for each of the digits in the reading.

Dial	*Reading*	*Place Value*
A		
B		
C		
D		

3. If Dial D were to move clockwise past the zero reading, what effect would this have on the reading for Dial C?

* *Answer*
Your order for corrugated iron would be for 18 square feet instead of 108 square feet.

Answers

1. 3148

2.

Dial	*Reading*	*Place Value*
A	3	Thousands
B	1	Hundreds
C	4	Tens
D	8	Ones

3. Dial C (the tens column) would be increased by 1. Thus, it would read 5 instead of 4, until Dial D moves 10 values again.

Addition

If you had a very long number line, numbers could be added by starting at the location of one number and moving to the right the units of the numbers to be added. This is how you added numbers in the previous section. Keep this in mind when you are adding numbers because it gives you a feel for the magnitude of the numbers when they are combined. But there are easier ways to go about adding numbers together. Here are three steps for addition:

1. Write the numbers in a column. Be sure to line up the place values (ones, tens, hundreds, and so on) of each number one above the other.

   For example, suppose you had four plumbing jobs planned for the month and you wanted to determine if you could take on another assignment. Your estimates of the times for the jobs were: Smith job—23 hours, Meyers job—91 hours, Johnson job—9 hours, Lewin job—105 hours. To add up the total hours, you first write them in a column:

$$\begin{array}{r} 23 \\ 91 \\ 9 \\ +105 \\ \hline \end{array}$$ Job hours

2. Add up the digits in the ones column. Write the answer below the line. If it is greater than 9 only write the furthest digit to the right. Carry the rest of the results to the top of the tens column and write it there. This is exactly what the meter does when a dial passes zero—the extra is moved to the next higher dial. In the example above, we would do the following:

Example:	*Process:*
Carry → 1 23 91 9 105 8	a. 3 + 1 + 9 + 5 = 18 b. Write the 8 in the ones column. c. Write the 1 above the tens column.

3. Continue the process for each column. The carried numbers are added into the column's sum.

Example

Carries → 11

23	*Job hours*
91	
9	
105	
228	*Total hours*

Process:

Tens Column:

a. 1 + 2 + 9 + 0 = 12
b. Write the 2 in the tens column
c. Write the 1 above the hundreds column

Hundreds Column:

a. 1 + 1 = 2
b. Write the two in the hundreds column

After adding up the job hours, you realize that you already will be overworked this month. Therefore, you decide not to take on another job, but give some thought to hiring an apprentice instead.

Example

An apprentice welder has an assignment of butt-welding five pieces of metal together. The lengths of the pieces are 55 cm, 89 cm, 7 cm, 10 cm, and 218 cm. She calculates what the total length of the metal after welding would be as follows:

Carries → 12

55	*Lengths of individual pieces*
89	
7	
10	
+ 218	
379 cm	*Total length or sum*

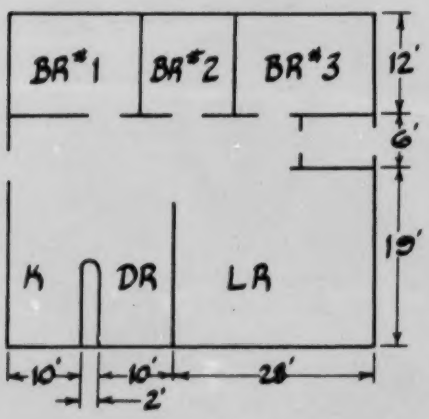


Figure 3

Exercises

1. Use the drawing in Figure 3 to answer the following:
   a. What is the length of the house?
   b. What is the width of the house?
   c. What is the length of the kitchen/dining area (including the counter)?

2. Calculate what the length of the house would be if the dimensions were changed as follows:

	Kitchen	*Counter*	*Dining Room*	*Living Room*	*Total Length*
a.	12	3	12	20	
b.	15	0	16	22	
c.	8	2	10	25	
d.	18	3	14	31	

3. Five bins of scrap metal contain loads weighing 580 lbs, 614 lbs, 92 lbs, 108 lbs, and 379 lbs. What is the total weight of the scrap metal?

4. Calculate the total weight accumulated in the bins for each day of the week illustrated below. Which bin collected the most scrap for the entire week?

	Bin #1	*Bin #2*	*Bin #3*	*Bin #4*	*Bin #5*	*Total Daily Weight*
Monday	89	4	372	490	154	
Tuesday	93	28	207	377	117	
Wednesday	124	70	222	85	398	
Thursday	47	32	190	207	237	
Friday	188	55	308	229	174	

Answers

1. a. Length of the house would be equal to the sum of the lengths of the rooms:

Carries →	1
Kitchen:	10 feet
Counter:	2 feet
Dining Room:	10 feet
Living Room:	+ 28 feet
Total Length:	50 feet

b. Width of the house equals:

Living Room:	19
Bath:	6
BR #1:	+ 12
	37 feet

c. Kitchen-Dining Area length:

Kitchen:	10
Counter:	2
Dining Room:	+ 10
	22 feet

2. The total length again would equal the sum of the lengths. The answers should be:

	Total Length
a.	47
b.	53
c.	45
d.	66

If you answered incorrectly to any of these, first check that you set the problem up correctly. For "a", you should have set it up as:

12
3
12
+ 20

Next check that you copied the numbers correctly in setting up the problem. Finally, re-check your addition. If you still cannot find the error, review the steps for addition or get some help from your instructor.

3. Total weight equals:

Carries –	22
	580
	614
	92
	108
	+ 379
	1773

4. To calculate the Total Daily Weight you should have totaled the weight in Bin 1, Bin 2, Bin 3, Bin 4 and Bin 5 for each day:

Day	*Total Daily Weight*
Monday	1109
Tuesday	822
Wednesday	899
Thursday	713
Friday	954

To find out which bin collected the most scrap in a week, you should have added down the columns for each Bin #:

Bin #	*Total Weight*
1	541
2	189
3	1299
4	1388
5	1080

Therefore Bin #4 collected the most waste in the week.

Subtraction

Subtraction involves taking away or removing something. This is represented by moving to the left on the number line. As with addition, you start subtraction by placing the numbers in a column, lining up the place values. But with subtraction, you can only work easily with two numbers at a time. The remaining steps in subtraction are:

1. Subtract the lower number in the ones place from the upper number. If the lower number is greater than the upper number, borrow 1 ten from the tens place. Record the result as shown below.

Example:

$$\begin{array}{r} 2 \\ 533 \\ -147 \\ \hline 6 \end{array}$$

Process:

a. Borrow one ten from the tens column. This gives you 13 in the ones column.

b. Subtract 7 from 13 to get 6. Write this in the ones column.

c. Cross out the three and change it to a two in the tens column so you don't forget you borrowed 1.

2. Continue in the same way with the remaining columns, working from right to left.

Example:	*Process:*
42 ~~5~~3 −147 386	Tens column: a. Four is greater than 2, so borrow 1 hundred from the hundreds column. This gives you 12 tens. b. Subtract 4 from 12 and write the result in the tens column. c. Change the 5 in the hundreds column to 4 to record your borrow. Hundreds column: d. Subtract 1 from 4 and record the result (3) in the hundreds column.

Example

A self employed journeyman checked to see if the balance in his checking account was enough to pay some outstanding bills and still leave him enough to buy $540 worth of supplies he needed. His balance was $1,972. He itemized and totaled the bills as follows:

Electricity	$ 140
Gasoline Credit Card	97
Telephone	46
Rent	+ 750
	$ 1,033

To determine how much money he would have after paying the bills, he subtracted the total of the bills from his balance:

```
    6
$ 1972
−1033
------
$  939
```

Therefore, he would have plenty to buy the needed supplies. How much would be left after buying the supplies?*

* *Answer*

To determine how much would be left after buying supplies, subtract the amount of the supplies ($540) from the $939 remaining after paying bills:

```
     8
$  939
 − 540
------
 $399
```

Exercises

1. A machinist makes 348 parts in a day. Of these, 23 are rejected by inspectors. How many good parts did she produce?

2. The machinist's weekly production figures are listed below. How many good parts did she make each day? What were her production figures for the week (Total produced, rejected, good parts)?

	Parts Produced	*Parts Rejected*	*Good Parts*
Monday	295	17	
Tuesday	303	19	
Wednesday	187	168	
Thursday	223	24	
Friday	352	33	

(On Wednesday, there was an error in the specifications which was not caught until late in the day. It was not the fault of the machinist).

3. The payroll figures for an industrial department are shown below. What is the take-home pay for each of the employees?

Employee ID	*Gross Weekly Pay*	*Total Deductions*	*Take-Home Pay*
210-62-4822	$ 424	$ 127	$
426-39-3001	392	107	
712-36-9143	519	185	
146-92-3242	358	81	
152-13-6491	387	96	
242-19-2990	525	114	

Answers

1. The number of good parts is determined by subtracting the number of bad parts from the total parts:

$$\begin{array}{r} 348 \\ -\ 23 \\ \hline 325 \end{array} \textit{ good parts}$$

2.

Day	*Good Parts*
Monday	278
Tuesday	284
Wednesday	19
Thursday	199
Friday	319

If you missed one or more, try to find your error by:

a. Checking that you set the problem up correctly: Parts produced above parts rejected with the place values lined up.
b. Checking that you copied the figures correctly.

c. Re-checking your subtraction. Did you remember to reduce when you borrowed?
d. Rereading the steps for subtraction.

The total production figures would be found by adding down each of the columns:

Total Parts Produced	*Total Parts Rejected*	*Total Good Parts*
1360	261	1099

3. Take-home pay is calculated by subtracting Deductions from Gross Pay. Answers are:

Employee ID	*Take-Home Pay*
210-62-4822	$ 297
426-39-3001	285
712-36-9143	334
146-92-3242	277
152-13-6491	291
242-19-2990	411

Multiplication

As an operation, multiplication is used to solve for a total amount when a particular amount occurs more than once. For example, suppose you had three bags of cement, each weighing 150 pounds. You are interested in determining the total weight of the cement on hand. One way to do this is to add the weights together:

```
Carry →  1
          150
          150
        + 150
        -----
          450 lb
```

An alternative is to use multiplication:

```
Carry →  1
          150
        × 3
        -----
          450 lb
```

In this case, either approach provides a fairly simple solution to the problem. But, what if you had 33 bags of cement?*

* *Answer*

If you had 33 bags of cement each weighing 150 pounds, determining the total weight by addition would involve writing 150 thirty-three times and adding up the figures. Multiplication would be much easier in this case:

```
   150
 ×  33
 -----
   450
  450
 -----
  4950 lbs
```

Single-Digit Multiplication

In a typical employment situation, there are about 250 work days in a year. To find out how many hours are worked in a year, you would multiply the number of work hours in a day (usually 8) times the 250 work days. The following steps show how to solve such a problem.

1. Set up the problem, the larger number above the smaller (the multiplier).

Example:	*Process:*
250 × 8 ↖ *Multiplier*	Line up the place values under each other.

2. Multiply the digit in the ones column by the multiplier. Write the result in the ones column. If it is greater than 9, carry the extra to above the tens column.

Example:	*Process:*
250 × 8 0	a. $8 \times 0 = 0$ b. Write the zero in the ones column.

3. Multiply the digit in the tens column by the multiplier. Add the result to the carry, if there is one above the tens column. Write the result in the tens column. If it is greater than 9, carry the extra to above the hundreds column.

Example:	*Process:*
Carry → 4 250 × 8 00	a. $8 \times 5 = 40$ b. Write the 0 in the tens column c. Carry the 4 to above the hundreds column.

4. Continue multiplying each place value by the multiplier and adding in the carry. When you reach the last place value, write the entire result of the operation (No need to carry).

Example:	*Process:*
Carry → 4 250 × 8 2000	a. $8 \times 2 = 16$ b. Add in the carry: $16 + 4 = 20$ c. Write the result in the hundreds and thousands columns.

Example

An electrician used 3,170 feet of wire on a job. He is interested in determining how much wire he would need for wiring 4 similar jobs. Therefore, he multiplies 3,170 by 4:

Carry → 2
3170
× 4
12680 ft.

Process:

1. $4 \times 0 = 0$
   Write the 0 in the ones column.
2. $4 \times 7 = 28$
   Write the 8 in the tens column
   Carry the 2 to above the hundreds column.
3. $4 \times 1 = 4$
   Add 4 to the carry: $4 + 2 = 6$
   Write the result in the hundreds column.
4. $4 \times 3 = 12$
   Write the result in the thousands and ten thousands column.

To wire 5 projects, he would need 3170 times 5 feet of wire:

Carry — 3
3170
× 5
15850 ft

Exercises

1. Suppose you are designing a bookcase that will hold a set of encyclopedias among other books. You would like the encyclopedias to fit on one shelf. If each volume is 4 cm wide and there are 28 volumes, how wide should your bookcase be?
2. A bid to print a 32-page booklet is $1740. How much would a bid to print 9 such booklets be?
3. A worker stamps 588 parts in an hour. How many parts would she produce in an 8-hour day?
4. The average hourly production of parts for all of the employees in a department are listed below. Calculate what their total production for the time periods listed would be.

	Average Hourly Production	*Time Period*	*Total Production for Time Period*
a.	492	4 hrs	
b.	387	5 hrs	
c.	405	6 hrs	
d.	519	3 hrs	
e.	538	7 hrs	
f.	456	9 hrs	

Answers

1. You determine total width by multiplying the width of one volume (4 cm) times the number of volumes (28):

3 — *Carry*
28
× 4
112 cm

2. 63 — *Carries*
$ 1740
× 9
$15,660

3. 76 — *Carries*
588
× 8
4704 parts

4. To solve these problems you should have multiplied the hourly production times the number of hours (time period), giving you the total production for the time period:

	Total Production
a.	1968
b.	1935
c.	2430
d.	1557
e.	3766
f.	4104

Multiple-Digit Multiplication

If the multiplier in a problem has more than one digit, the procedures for multiplying are somewhat different. As an example, multiply the 250 work days times a daily salary of $78 to determine an annual income. Steps to follow in solving the problem are:

1. Set up the problem. Place the larger number over the smaller number and line up the place values.

```
  250
× 78
-----
```

2. Multiply the 250 by the number in the ones column of the multiplier: 8. This is done exactly the same way as was done for single-digit multiplication. Therefore the result of this step would be:

```
Carry →  4
  250
× 78
-----
 2000
```

3. Next, multiply the 250 by the figure in the tens column: 7. Again use the same procedures, but record the results in a different location. Record them below the first result, beginning in the column under the multiplier and working right to left. Carries are recorded above those resulting from the first step.

Example:

```
Carries → 3
          4
  250
× 78
-----
 2000
 1750
```

Process:

a. $7 \times 0 = 0$; Record in the tens column.
b. $7 \times 5 = 35$; Record the five in the hundreds column.
c. Write the carry above the 4 from Step 1.
d. $7 \times 2 = 14$
e. Add in the carry: $14 + 3 = 17$
f. Record the result to the left of the 5.

4. The final step in multiple-digit multiplication is addition. Add the results of the multiplications together to produce the final result:

```
Carries →   3
        →   4
            250
          × 78
        ------
            2000
           +1750
        ------
        $ 19500  ← Final result
```

Example

An apprentice was instructed to check the inventory of a particular part. Parts were stored by the gross (12 dozen), and he counted 138 gross. To determine the total number of parts, the apprentice first multiplied 12 times 12 to find the number of parts in a gross:

```
   12
 × 12
 ----
   24
  12
 ----
  144
```

He then multiplied the 144 parts in a gross times the 138 gross to get the total parts:

```
Carries →   11
        →   33
            144
          × 138
        ------
a →         1152
b →          432
c →          144
        ------
d →        19872
```

Process:

a. $8 \times 144 = 1152$; Record right to left starting in the ones column.
b. $3 \times 144 = 432$; Record right to left starting in the tens column.
c. $1 \times 144 = 144$; Record right to left starting in the hundreds column.
d. Add the results of the 3 single digit multiplication operations.

Exercises

1. One row of brick in a wall requires 118 bricks. How many bricks will be needed to lay 79 additional rows of brick?
2. How many bricks will be required to complete the following walls:

Number of Bricks In One Row	*Number of Rows*	*Total Bricks*
374	54	
2227	396	
99	88	
937	42	

3. A printing apprentice is preparing for a job to offset print 550 copies of a 75-page booklet. How much paper will she need?

4. An apprentice's wage scale for the next four years is shown below. If there are 250 work days in a year, what will his yearly gross income be for each of the four years.?

	Daily Rate	*Yearly Income*
Year 1	$55	
Year 2	$62	
Year 3	$69	
Year 4	$77	

Answers

1. The answer is found by multiplying the number of bricks in a row (118) times the number of rows (79):

```
  15   -
  17   -  Carries
 118
×  79
------
1062
826
------
9322 bricks
```

2. Using the same procedure you should have found the following:

	Total Bricks
374 × 54	20,196
2227 × 396	881,892
99 × 88	8,712
937 × 42	39,354

Try to find any errors by checking your copying and multiplying. Check your carries.

3. She will need 550 copies of each of 75 pages:

```
  3   -
  2   -  Carries
 550
× 75
------
2750
3850
------
41250 pages
```

4. Yearly income is determined by multiplying daily rate by 250 days per year.

	Yearly Income
Year 1	$13,750
Year 2	$15,500
Year 3	$17,250
Year 4	$19,250

Division

Division is the opposite of multiplication. In multiplication the purpose is to find a total for multiple cases of an occurrence. Division, on the other hand, involves determining a value associated with *one* occurrence when you have information on multiple happenings. For example, if a catalog gave price information for parts in quantities of 12, you would use division to find the price of one part (dividing the total price by 12). Or, if you needed to know how many 2′ lengths you could cut out of an 8′ length of lumber, you would divide 8 by 2 to find 4 pieces.

Single-Digit Division

A machinist produces 296 parts in an eight-hour day. To determine how many parts on the average were produced per hour, you would divide 296 by 8. The steps for performing this operation are as follows:

1. Set up the problem as shown below:

   divisor → $8\overline{)296}$ ← *dividend*

2. Divide the divisor into the first digit of the dividend. Write the result *above* the dividend.

Example:	*Process:*
$\begin{array}{r} 0 \\ 8\overline{)296} \end{array}$	a. 2 cannot be divided by 8 b. Write 0 above the 2 in the dividend

3. Multiply the result of this by the divisor. Write the result *below* the dividend. Subtract to find a remainder, or how much is left after the division.

Example:	*Process:*
$\begin{array}{r} 0 \\ 8\overline{)296} \\ 0 \\ \hline 2 \end{array}$ ← *remainder*	a. $0 \times 8 = 0$ b. Write 0 below 2 in the dividend c. Subtract 0 from 2 to get the remainder

4. Write the next digit in the dividend next to the remainder. Divide this figure by the divisor.

Example:	*Process:*
$\begin{array}{r} 03 \\ 8\overline{)296} \\ 0 \\ \hline 29 \\ 24 \\ \hline 5 \end{array}$	a. Bring down the 9 and write next to the 2 remainder b. Divide 8 into 29 c. Write the result (3) above the 9 d. Multiply 3×8 e. Write the result below the 29 f. Subtract to find the remainder

5. Continue Step 4 until there are no more digits to bring down.

Example:	*Process:*
$\begin{array}{r} 037 \\ 8\overline{)296} \\ 0 \\ \hline 29 \\ 24 \\ \hline 56 \\ 56 \\ \hline 0 \end{array}$	a. Bring down the 6 next to the 5 remainder b. Divide 56 by 8 c. Write the result (7) above the 6 d. Multiply 7×8 e. Write the result below the 56 f. Subtract to find the remainder

Some Other Guidelines

a. The zero in the result above has no value as a place holder. That is, 037 = 37. You can drop the 0 and write the result 37.

b. If there is a remainder after you have finished dividing, you can include it as part of the result. For example, suppose we had divided 297 by 8:

$$\begin{array}{r} 037\ \frac{1}{8} \\ 8\overline{)297} \\ 0 \\ \hline 29 \\ 24 \\ \hline 57 \\ 56 \\ \hline 1 \end{array}$$

The remainder can be written above the divisor as a fraction and included with the result.

In the example, the fraction is created by putting 1 over 8. Thus, the solution to this problem would be 37-⅛. More on fractions is provided in the next chapter.

c. Sometimes you will not be interested in retaining the remainder. For example, if you wanted to know how many 8mm lengths you could get out of a piece of stock 297mm long, 37 would be the appropriate answer. The extra ⅛ of a piece does you no benefit—it is scrap.

d. On the other hand, if you were interested in knowing how long each piece would be if you cut a 297 mm long sheet into 8 equal length pieces, the correct answer would be 37-⅛. To measure and cut correctly and utilize the entire sheet, you would need to retain the ⅛.

Exercises

1. A 261″ length of extruded aluminum is to be cut into 6″ sections. How many sections would result?

2. A stack of 3mm-thick sheets of plastic is 252mm high. How many sheets are in the stack?

3. Two wholesale catalogs have the following price listings for 10-inch carbide-tipped saw blades.

Catalog A	*Catalog B*
8 blades for $192	6 blades for $138

Which catalog has the lowest priced saw blades?

Answers

1. The number of sections is calculated by dividing the total length by the length per section:

```
  043
6)261      43 Sections
  0
 ---
  26
  24
 ---
   21
   18
  ---
```

2.
```
  084
3)252      84 Sheets
  0
 ---
  25
  24
 ---
   12
   12
  ---
```

3. *Price for one blade*

Catalog A:	Catalog B:
$24	$23
8)192	6)138
16	12
32	18
32	18

Blades in Catalog B are less expensive.

Multiple-Digit Division

Multiple-digit division operates in the same manner as single-digit division. However, since more than one digit is used, the operation requires more estimation, or trial and error on your part. Suppose you want to cut an 840mm piece of dowel into 36mm lengths. To determine how many pieces you would have, divide as follows:

Example:	*Process:*
3	a. 8 is not divisible by 36, so write a 0
02*A*	b. Estimate how many times 36 will go into 84. A rule of thumb is to use the first digits: 8 divided by 3 is 2. So try 2.
36) 840	
0	c. Multipy 2 × 36. Subtract. Bring down the zero.
84	d. Estimate the next figure: 12 divided by three is 4. Try 4. Multiply 4 × 36.
72	
120	e. 4 was too large since 144 is greater than the remainder (120). Try 3.
1AA	
108	f. Multiply 3 × 36. The remainder is scrap. The answer is 23 pieces of dowel.
Remainder → 12	

Exercises

1. Twelve inches is equal to one foot. How many feet are in 408 inches?
2. A farmer is planning to plant a block of pepper plants. He wants the plants to be 12″ apart. How many plants will he need to plant one row 25′ (300″) long? How many will he need for 14 such rows?
3. An incremental adjustment on a control knob moves a dial pointer 15°. How many adjustments will have to be made to move the dial 345°?
4. The following is a task order for cutting steel pipe into segments. Calculate how many segments you would get from each piece. Also write in the remainder. All measurements are in millimeters.

	Pipe Length	*Length of Each Cut Segment*	*Number of Segments*	*Remainder*
a.	2498	127		
b.	1924	88		
c.	983	62		
d.	624	48		

Answers

1. To determine the number of feet, you divide the number of inches by the number of inches in one foot.

```
   34 feet
12)408
   36
   ---
   48
   48
   ---
```

2.
```
   25 plants
12)300
   24
   ---
   60
   60
   ---
```

For 14 such rows he would need 14 × 25 plants or 350 plants.

3.
```
   23 adjustments
15)345
   30
   ---
   45
   45
   ---
```

4. To find the number of segments, divide the pipe length by the length of each cut segment. The remainder is scrap.

	Number of Segments	*Remainder*
a.	19	85
b.	21	76
c.	15	53
d.	13	0

Chapter Example

The four operations do not have to be used alone, as some of the exercises illustrated. Some problems require use of multiplication, division and addition, division and subtraction or other combinations of operations. The following example shows how multiple operations are used to solve a problem.

The Problem

A painter is planning to paint a room—the walls and closet Robin's Egg Blue and the ceiling Desert Sand. She planned to use one coat on both walls and ceilings, with no primer. The dimensions of the room are as follows:

	Area (Square Feet)
Three Walls	128 (each)
One Wall	114
Ceiling	272
Closet	96

Prices for the paints by the quart and gallon, and the areas covered by the quantities are below:

Paint	*Size*	*Price*	*Coverage (Sq Ft)*
Robin's Egg Blue	Gallon	$12	480
	Quart	$ 4	120
Desert Sand	Gallon	$11	360
	Quart	$ 4	80

The painter has allowed $45 to buy paint. How much money will she have left over to do the trim?

The Solution

The problem can be divided into five steps that lead to the solution:

1. Determine what the total square footage to be painted in each color will be.
2. Based on total square footage and the coverage of the paints, find out how much paint is required.
3. Decide what size and how many cans to buy (The larger sizes are more economical, but there may be more waste).
4. Determine the price of the paint.
5. Calculate how much money would be left over.

Step 1

To calculate total square footage:

a. *Walls*:
- There are 3 walls with 128 sq ft each. The total of these would be $128 \times 3 = 384$.
- Add in the other wall areas:

$$\begin{array}{r} 384 \\ 114 \\ +\ 96 \\ \hline \text{Total sq ft: } 594 \end{array}$$

b. *Ceiling*: Total is 272 sq ft

Step 2

To determine the amount of paint required, divide the total square footage by the amount covered per gallon of paint. This gives the total gallons and/or portions of gallons.

a. *Walls*:

$$\begin{array}{r} 1 \text{ gallon} \\ 480\overline{)594} \\ \underline{480} \\ 114 \end{array}$$

The remainder is the square footage *not* covered by the 1 gallon.

Divide the remainder by the amount covered by a quart to determine the number of quarts needed.

$$120\overline{)114}$$

Since 114 is not divisible by 120, 1 quart should be enough to cover the remainder.

b. *Ceiling*:

$$350\overline{)272}$$

One gallon would be enough to cover.

Now see if it would be less expensive to buy quarts:

$$\begin{array}{r} 3 \\ 80\overline{)272} \\ \underline{240} \\ 32 \end{array}$$

Three quarts would *not* be enough to cover. 32 sq ft remainder.

Step 3

Based on the division in Step 2, you decide that the following paint is needed:

a. *Robin's Egg Blue*: 1 Gallon
1 Quart

Since the painter is planning to use a roller, and the 120 sq. ft. coverage of a quart is not a great deal larger than the 114 sq. ft. to be covered, she decides to purchase an extra quart.

b. *Desert Sand*: 1 Gallon

Step 4

The price of the paint is determined from the price list and the quantities desired:

a. *Robin's Egg Blue*:

1 Gallon =	\$12.00
2 Quarts = \$4 × 2 =	8.00

b. *Desert Sand*:

1 Gallon =	11.00
Total Price =	\$31.00

Step 5

To find out how much money would be left over for the trim, subtract the total price of the paint from the amount allocated:

$$\begin{array}{r} \$\ 45 \\ -31 \\ \hline \$\ 14 \end{array}$$

There would be \$14 left.

Self-Test Exercises

Answer the following questions and problems. Check your answers with those in the Appendix. If you answer less than 7 items correctly, repeat your work in this chapter. If you answer 7 or 8 correctly you have mastered basic mathematical operations using whole numbers. Go on to the next chapter.

1. Find a seven-digit whole number somewhere at work or at home. (For example, a telephone number, serial number, or a bank balance if you're lucky). Write the number below. Identify the place values for each of the digits of your number.

2. How much would you have to add to the ones column of your number from question 1 to make the digit in the tens column increase by 1? What would be the value in the ones column?

Use the illustration in Figure 4 to answer questions 3 and 4.

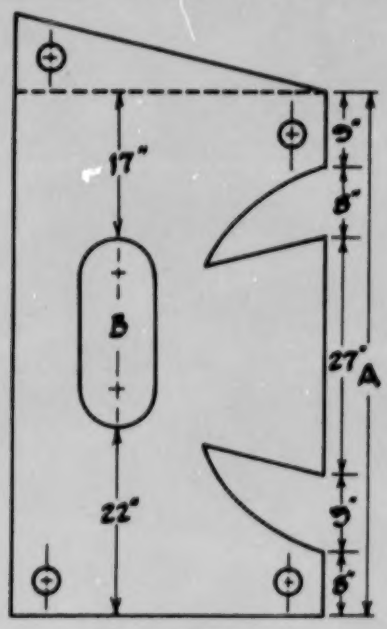


Figure 4

3. What is the length of dimension A?

4. What is the length of slot B?

Read the following situation to answer questions 5-7.

A plumber is estimating what his total expenditures for gasoline this year will be. He uses the following estimates in his calculations:

Average distance driven per week: 247 miles
Number of weeks worked per year: 50 weeks
Average mileage: 17 miles per gallon
Average price of gas: 95¢/gallon

5. Estimate the number of miles he will drive this year.

6. **Approximately how many gallons of gas will he use this year?**

7. **About how much will he spend on gas this year? (Your answer will be in cents. To change it to dollars, divide by 100).**

8. **A carpenter needs the following lengths of two-by-fours:**

Quantity	*Length*
3	72″
4	18″
3	40″
5	12″
3	32″

There are 6 eight-foot long (96″) two-by-fours on site. Does she have enough lumber to make the required cuts?

3. Fractions

Chapter Overview

Purpose:	To develop skills in working with fractions in work-related problems. An apprentice will develop an understanding of what fractions are and an ability to solve problems using common and decimal fractions and percents.
Preassessment Score:	Write in the following space the number of correct answers from Pretest questions 9-16: _____ . If you answered seven or eight questions correctly, skip to Chapter 4. If you missed two or more questions, work through this booklet.
Prerequisites:	Chapter 1 of this booklet. Completion of Chapter 2 of this booklet or a mastery of addition, subtraction, multiplication and division using whole numbers.
Resources:	Time—about 3-4 hours to complete. You do not need to work through the chapter in one sitting. Materials—paper, pencil.
Performance Measure:	A thirty-minute paper-and-pencil Posttest, to be taken after completing the entire booklet.
Standards:	To be successful, you must answer correctly 80% of the Posttest items.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-Test Exercises and the P sttest.

Introduction and Objectives

In Chapter 2 the operations you used dealt solely with whole numbers. However, as an apprentice or journeyman you will be exposed to fractions and be required to perform the arithmetic operations on both common and decimal fractions. For example, many measurements you make will not be in whole feet and inches, but in fractions: 2' 1-3/16". You most likely will be required to work with decimals if you perform any calculations involving money. Paychecks and bills generally are not whole numbers—for example a bill for $10.46. Even our car odometers usually display in decimals. The wheel that goes around the fastest is tenths (1/10's) of a mile. If you think about it, you can probably come up with numerous uses of fractions in your everyday work and home activities. This Chapter will help you deal with problems that involve the use of fractions. After completing the chapter, you will demonstrate your ability to:

1. Reduce and expand common fractions.
2. Find the least common denominator.
3. Perform the four basic operations using common fractions.
4. Convert common fractions to decimal fractions and decimals to common fractions.
5. Round decimals to a desired number of places.
6. Perform the four basic operations using decimal fractions.
7. Compute percents.

Fractions as Parts of a Whole

If something were divided into two equal parts, each part would be one-half of the total. One-half is a fraction and is written as ½. Fractions are numbers used to describe parts of a whole. For example, a circle could be divided into four equal parts, as shown in Figure 5. Each part represents ¼ of the total circle. The fraction ¼ is called a common fraction.

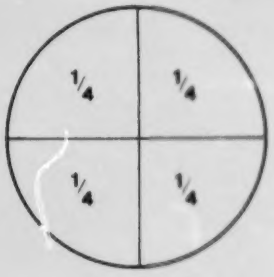


Figure 5

As you can see, a common fraction has two numbers. The number on top is called a numerator. The number on the bottom is called a denominator.

- The *numerator* tells how many parts are in the fraction.
- The *denominator* is the total number of parts in the whole.

Figure 6

In Figure 6, each part is ¼ of the total square. If you only considered the shaded portion of the square, you would have 2 of the total 4 parts. This would be written ²⁄₄. If you used three parts, how would the fraction be written?*

A whole number can be divided into as many parts as desired. You could take the square above and divide each part into four parts. This is illustrated in Figure 7. Now the total number of parts is 16. Each individual part has a value of 1/16. Two parts would be written ²⁄₁₆, and so on.

* *Answer*

The fraction is written ¾. This is because you used 3 parts (the numerator) of the total 4 parts (denominator). Since you write the numerator over the denominator you have ¾.

A whole number can be divided into as many parts as desired. You could take the square above and divide each part into four parts. This is illustrated in Figure 7. Now the total number of parts is 16. Each individual part has a value of 1/16. Two parts would be written 2/16, and so on.

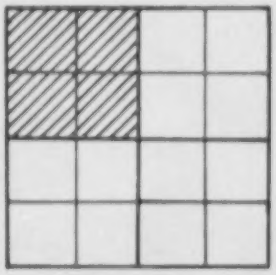


Figure 7

If you took the shaded portion of the square, this would be 1/16 of the total. Notice that the shaded portion is the same size as one part in Figure 6. Thus, the same portion can be represented in different ways, 1/16 or 1/4. It also could be written as 2/8. Can you draw a figure that would show that 2/8 is the same as 1/4? First, trace Figure 6, then divide your figure into 8 equal parts.

Reducing Fractions

The fractions 1/16 and 1/4 are called *equivalent fractions* because they represent the same portion of the whole. You can change 1/4 to 1/16 and it would not change its value. This is done by multiplying both the numerator and the denominator by 4:

$$\frac{1 \times 4}{4 \times 4} = \frac{4}{16}$$

You can change it back by dividing both numbers by 4:

$$\frac{4 \div 4}{16 \div 4} = \frac{1}{4}$$

This second operation is called *reducing* the fraction. To reduce a fraction you divide both the numerator and denominator by a *common factor*. This is a number which divides into both terms with no remainder. In the example above, the common factor divided into both terms was 4. Would 2 also be a common factor of 1/16? Try dividing both terms by 2. What is the result?*

When no common factor exists, the fraction is *reduced to lowest terms*. Generally, fractions are used in their lowest terms. For example, if you measured the length of a room you would probably record it as 26-1/2' instead of 26-16/32'. Fractions in their lowest terms are easier to work with.

* *Answer*

Two is also a common factor of 1/16. Dividing both terms by 2 would give you:

$$\frac{4 \div 2}{16 \div 2} = \frac{2}{8}$$

This shows mathematically what you have already shown with a drawing—that 1/16 and 2/8 are equivalent fractions.

Example

A scale measures weight in ounces, which are sixteenths of a pound. Five measurements obtained from the scale were $\frac{8}{16}$, $\frac{7}{16}$, $\frac{2}{16}$, $\frac{12}{16}$ and $\frac{13}{16}$. It was an apprentices' task to reduce the weights to lowest terms before recording them in a log. She did this by:

1. Identifying a common factor in the terms
2. Dividing the common factor into both the numerator and the denominator
3. Checking to see if the terms share another common factor. If so, repeating steps 2 and 3.

$\frac{8}{16}$: Step 1. Both numbers are divisible by 8.

Step 2. $\frac{8 \div 8}{16 \div 8} = \frac{1}{2}$

Step 3. No common factor exists.

$\frac{7}{16}$: Step 1. There is no common factor. It is reduced to lowest terms.

$\frac{2}{16}$: Step 1. Two is a common factor.

Step 2. $\frac{2 \div 2}{16 \div 2} = \frac{1}{8}$

Step 3. No common factor exists.

$\frac{12}{16}$: Step 1. Both numbers are divisible by 2.

Step 2. $\frac{12 \div 2}{16 \div 2} = \frac{6}{8}$

Step 3. Two is a common factor again.

Step 2. $\frac{6 \div 2}{8 \div 2} = \frac{3}{4}$

Step 3. No common factor exists.

$\frac{13}{16}$: Step 1. The fraction is in lowest terms.

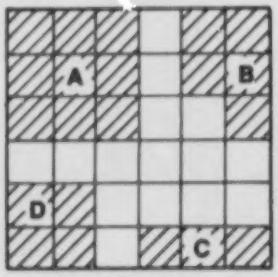


Figure 8

Exercises

1. Refer to Figure 8. Write the fractions which represent the following shaded areas:

   A.
   B.
   C.
   D.

2. Reduce the fractions to the lowest terms:

   A.
   B.
   C.
   D.

3. Write an equivalent fraction for each of your answers to Exercise 2 by multiplying both terms by 4. Are any of your results the same as you wrote for Exercise 1? Why or why not?

   A.
   B.
   C.
   D.

Answers

1. A. $\frac{9}{36}$ B. $\frac{5}{36}$ C. $\frac{3}{36}$ D. $\frac{1}{36}$

2. A. $\frac{9 \div 9}{36 \div 9} = \frac{1}{4}$

   B. $\frac{5}{36}$ is in lowest terms

   C. $\frac{3 \div 3}{36 \div 3} = \frac{1}{12}$

   D. $\frac{4 \div 4}{36 \div 4} = \frac{1}{9}$

3. A. $\frac{1 \times 4}{4 \times 4} = \frac{4}{16}$

   B. $\frac{5 \times 4}{36 \times 4} = \frac{20}{144}$

   C. $\frac{1 \times 4}{12 \times 4} = \frac{4}{48}$

   D. $\frac{1 \times 4}{9 \times 4} = \frac{4}{36}$

D has the same answer as in Exercise 1. This is because to reduce the answer you divided by 4. In multiplying by 4 it brings you back to where you started.

Mixed Numbers

When a number contains a whole number and a fraction, it is called a *mixed number*. An example of this is $8\frac{3}{4}$ or $5\frac{2}{3}$. Another way to write mixed numbers is as improper fractions. In an *improper fraction*, the numerator is larger than the denominator. In a *proper fraction*, the numerator is smaller than the denominator. For example, $8\frac{3}{4}$ could be written as $\frac{35}{4}$—they are equivalent. Divide 35 by 4 to check that this is true. Be sure to keep the remainder.*

For some operations, such as multiplication and division, you need to write mixed numbers as improper fractions. But, when you obtain the result of an operation, such as summing the lengths of a series of copper pipe segments, you generally want to record it as a mixed number. Therefore, you will need to know how to change the form of the fraction.

* *Answer*

$$\begin{array}{r} 8\frac{3}{4} \\ 4\overline{)35} \\ \underline{32} \\ 3 \end{array}$$

To Change a Mixed Number to an Improper Fraction	*Example*: 9-4/5
1. Multiply the denominator of the fraction by the whole number	$5 \times 9 = 45$
2. Add the result to the numerator.	$45 + 4 = 49$
3. Write the result over the denominator.	$\frac{49}{5}$

To Change an Improper Fraction to a Mixed Number	*Example*: 49/5
1. Divide the numerator by the denominator.	$5\overline{)49}$ R 4
2. Write the remainder as a fraction	4/5
3. Combine the results	9-4/5

Exercises

1. A work specification for cutting lengths from aluminum bar is outlined below. Write each length as an improper fraction so that total length required can be determined.

	Number of Pieces	*Length*	*Improper Fraction*
a.	5	5-3/8"	
b.	4	12-5/16"	
c.	2	8-1/4"	
d.	8	7-7/8"	

2. Change the following measurements to mixed numbers:

a. $\frac{19''}{4}$ c. $\frac{83''}{9}$

b. $\frac{27''}{12}$ d. $\frac{48''}{16}$

Answers

1. a. 5-3/8": 1. $8 \times 5 = 40$
   2. $40 + 3 = 43$
   3. 43/8" is the improper fraction

   b. 12-5/16": 1. $12 \times 16 = 192$
   2. $192 + 5 = 197$
   3. 197/16" is the improper fraction

   c. 8-1/4": 1. $4 \times 8 = 32$
   2. $32 + 1 = 33$
   3. 33/4" is the improper fraction

   d. 7-7/8": 1. $8 \times 7 = 56$
   2. $56 + 7 = 63$
   3. 63/8" is the improper fraction

2. a. $4\overline{)19}$ R 3 — 4-¾ is the mixed number

b. $12\overline{)27}$ R 3 — 2-3/12 or 2-¼ is the mixed number

c. $9\overline{)83}$ R 2 — 9-2/9 is the mixed number

d. $16\overline{)48}$ R 0 — The result is a whole number since there is no remainder.

Addition With Fractions

Adding Fractions with the Same Denominators

When fractions to be added have the same number in their denominators, addition involves three steps:

Steps:	*Example*:
	⅜ + ⅝ + ⅞
1. Add the numbers in the numerators	3 + 5 + 7 = 15
2. Write the result over the denominator	15/8
3. Change improper fractions to mixed numbers	1-⅞

Adding Fractions with Different Denominators

When fractions to be added have different denominators it is necessary to find a denominator that they can share in common before adding. For example, you could not add ⅜ + ¼ in the form they are in. As you can see in Figure 9, their parts are fractions of different wholes. But by giving them the same denominator, as in Figure 10, it makes sense to add them: ⅜ + ⅜ = ⅝.

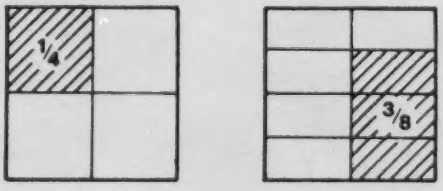


Figure 9

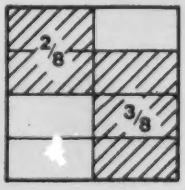


Figure 10

Therefore, the first step in adding fractions is to find the *lowest common denominator* or *LCD*. The LCD is the smallest number that is evenly divisible by all the denominators. To find the LCD for a set of fractions, use the following steps:

Steps:	*Example*: $\frac{1}{4} + \frac{1}{3} + \frac{3}{8}$
1. Try the largest denominator as an LCD. If it is divisible by the other denominators, it is the LCD	1. 8 is divisible by 4, but not by 3. 8 is not the LCD.
2. Multiply the largest denominator by 2. Try this as the LCD.	2. $8 \times 2 = 16$. 16 is divisible by 4 but not be 3. 16 is not the LCD.
3. Multiply the largest denominator by 3. Try this as the LCD. Continue multiplying the largest denominator by 4, 5, 6 and so on until you find a LCD.	3. $8 \times 3 = 24$. 24 is divisible by 4 and by 3. 24 is the LCD.

After finding the LCD, change the fractions to equivalent fractions having common denominators. This is what was done in Figure 10, changing the $\frac{1}{4}$ to $\frac{2}{8}$. Do this by dividing the denominator of each fraction into the LCD and multiplying the result times the fraction's numerator. This result is placed over the LCD. For the example, you would do the following:

$\frac{1}{4}$: a. Divide 24 by 4 = 6
b. Multiply 6 times 1 = 6
c. $\frac{6}{24}$ is the equivalent fraction

$\frac{1}{3}$: a. Divide 24 by 3 = 8
b. Multiply $8 \times 1 = 8$
c. $\frac{8}{24}$ is the equivalent fraction

$\frac{3}{8}$: a. Divide 24 by 8 = 3
b. Multiply $3 \times 3 = 9$
c. $\frac{9}{24}$ is the equivalent fraction

Reduce the three equivalent fractions to show that they are equivalent.* Since you now have common denominators, you are able to add the fractions using the three-step process:

$$\frac{6}{24} + \frac{8}{24} + \frac{9}{24} = \frac{6+8+9}{24} = \frac{23}{24}$$

* *Answers*

$$\frac{6 \div 6}{24 \div 6} = \frac{1}{4} \qquad \frac{8 \div 8}{24 \div 8} = \frac{1}{3} \qquad \frac{9 \div 3}{24 \div 3} = \frac{3}{8}$$

Example

The dimensions of a sheet metal utility box are shown in Figure 11. What is the total length of metal needed to make the box?

The total length is equal to the sum of the dimensions:

$$\frac{3}{8} + 2\frac{3}{4} + 6\frac{1}{2} + 2\frac{3}{4} + \frac{3}{8}$$

To solve the problem:

1. Find the LCD. First try the largest denominator, 8, as the LCD. Since 8 is divisible by 4 and 2, 8 is the LCD.
2. Write the fractions in terms of the LCD:

$$\begin{aligned} \frac{3}{8} &= \frac{3}{8} \\ 2\frac{3}{4} &= 2\frac{6}{8} \\ 6\frac{1}{2} &= 6\frac{4}{8} \\ 2\frac{3}{4} &= 2\frac{6}{8} \\ \frac{3}{8} &= \frac{3}{8} \end{aligned}$$

3. Add up the fractions:

$$\frac{3}{8} + \frac{6}{8} + \frac{4}{8} + \frac{6}{8} + \frac{3}{8} = \frac{22}{8}$$

4. Add up the whole numbers:

$$2 + 6 + 2 = 10$$

5. Change the improper fraction, reduce terms, and combine with the whole number:

$$\frac{22}{8} = 2\frac{6}{8} = 2\frac{3}{4}$$
$$10 + 2\frac{3}{4} = 12\frac{3}{4}$$

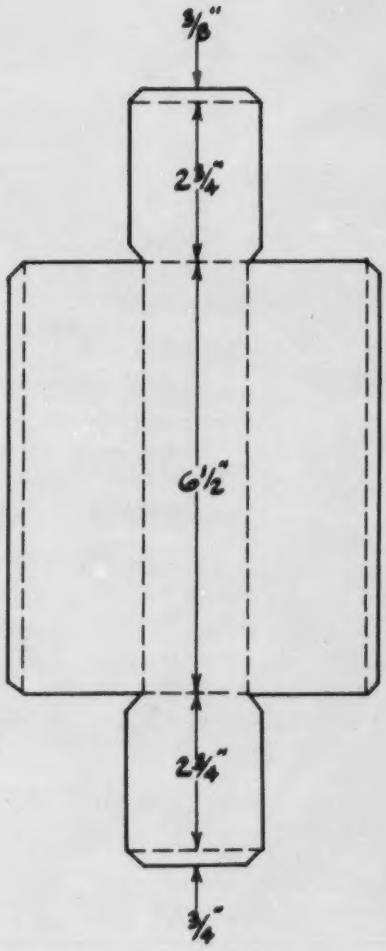


Figure 11

Exercises

1. Find the LCD for the following groups of fractions:

a.	$\frac{3}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{2}{3}$
b.	$\frac{3}{5}$	$\frac{1}{4}$	$\frac{1}{2}$	
c.	$\frac{2}{9}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{4}$
d.	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{12}$	

2. What is the length of the pin in Figure 12?
3. Thicknesses of materials used in an exterior wall are as follows:

Brick:	$2\frac{2}{3}$"
Insulation:	$\frac{5}{8}$"
Studs:	$3\frac{3}{4}$"
Sheetrock:	$\frac{1}{2}$"
Wallcovering:	$\frac{1}{16}$"

What is the total thickness of the wall?

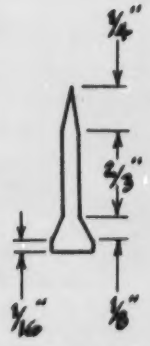


Figure 12

Answers

1. a. First try 16. It is not divisible by 3.
   Try $16 \times 2 = 32$. It is not divisible by 3.
   Try $16 \times 3 = 48$. It is divisible by all four denominators and is the LCD.
   b. First try 5. Not divisible by 4 or 2.
   Try $5 \times 2 = 10$. Not divisible by 4.
   Try $5 \times 3 = 15$. Not divisible by 4 or 2.
   Try $5 \times 4 = 20$. 20 is the LCD.
   c. Try 9.
   Try $9 \times 2 = 18$.
   Try $9 \times 3 = 27$.
   Try $9 \times 4 = 36$. 36 is the LCD.
   d. Try 12. 12 is the LCD.

2. The length of the pin is the sum of the lengths:

   $$\frac{1}{4} + \frac{2}{3} + \frac{1}{8} + \frac{1}{16}.$$

   - The LCD is 48
   - Convert the fractions:

   $$\frac{1}{4} = \frac{12}{48} \qquad \frac{1}{8} = \frac{6}{48}$$
   $$\frac{2}{3} = \frac{32}{48} \qquad \frac{1}{16} = \frac{3}{48}$$

   - Add the numerators and write over the LCD.

   $$\frac{12 + 32 + 6 + 3}{48} = \frac{53}{48} = 1\frac{5}{48}$$

3. The thickness of the wall is equal to the sum of the widths of the materials:

   $$2\frac{2}{3} + \frac{5}{8} + 3\frac{3}{4} + \frac{1}{2} + \frac{1}{16}$$

   - The LCD is 48

     Convert the fractions:

     $2\frac{2}{3} = 2\frac{32}{48}$ $\quad \frac{1}{2} = \frac{24}{48}$
     $\frac{5}{8} = \frac{30}{48}$ $\quad \frac{1}{16} = \frac{3}{48}$
     $3\frac{3}{4} = 3\frac{36}{48}$

   - Add the whole numbers: $2 + 3 = 5$
   - Add the fractions:

   $$\frac{32 + 30 + 36 + 24 + 3}{48} = \frac{125}{48} = 2\frac{29}{48}$$

   - Combine the whole number and fraction

   $$5 + 2\frac{29}{48} = 7\frac{29}{48}\text{" thick}$$

Subtraction With Fractions

The process for subtracting fractions is similar to addition. The following steps show you how to subtract fractions.

Steps:	*Example*: $\frac{3}{4} - \frac{3}{8}$
1. Find the lowest common denominator	1. $6 \times 2 = 12$; 12 is the LCD
2. Write the fractions in terms of the LCD	2. $\frac{3}{4} = \frac{9}{12}$ $\frac{3}{8} = \frac{6}{12}$
3. Subtract the numerators of the fractions and write above the denominator	3. $\frac{9-6}{12} = \frac{3}{12}$
4. Write the result as a proper fraction reduced to lowest terms.	4. $\frac{3}{12} = \frac{1}{4}$

Example

A bolt is to be used to attach a plate to an undercarriage. The combined width of the metal and washers is 2-⅞". The length of the bolt is 3-³⁄₁₆". An apprentice was told to find the length of the bolt that would be exposed to hold a nut. To do this, he subtracted 2-⅞" from the total length of the bolt (3-³⁄₁₆"). He used the following steps:

1. Find the LCD: 16 is divisible by both denominators.
2. Write the fractions in terms of the LCD: $2\text{-}\frac{7}{8} = 2\text{-}\frac{14}{16}$
   $3\text{-}\frac{3}{16} = 3\text{-}\frac{3}{16}$
3. Subtract the fractions: $\frac{3}{16} - \frac{14}{16}$. Since $\frac{3}{16}$ is less than $\frac{14}{16}$, the apprentice needed to *borrow* from the whole number. This is just like borrowing 10 when subtracting whole numbers. In this case it means taking 1 or $\frac{16}{16}$ from the whole number and combining it with the fraction:
   $$3\text{-}\tfrac{3}{16} = 2 + 1\text{-}\tfrac{3}{16} = 2\text{-}\tfrac{19}{16}$$
   Then, the fractions can be subtracted:
   $$\tfrac{19}{16} - \tfrac{14}{16} = \tfrac{5}{16}$$
4. Subtract the whole numbers: Since 1 was borrowed from the 3, only 2 remains.
   $$2 - 2 = 0$$
5. Combine the results and reduce to lowest terms.
   $$0 + \tfrac{5}{16} = \tfrac{5}{16}$$
   which is in lowest terms.

Exercises

1. A carpenter is planning to cut 5 two-by-fours to 18-¾". The lengths of the lumber are in the table below. Find out how much of each of the two-by-fours will be left after she makes the cuts.

	Total Length	*Length Remaining After Making Cut*
a.	27-⅞"	
b.	36"	
c.	42-⁵⁄₁₆"	
d.	50-⁹⁄₁₀"	
e.	65-½"	

2. An operator moved a control knob clockwise ⅝ of a complete turn. He had only wanted to move it ⅜ of a complete turn. How far should he move the knob counter-clockwise to make the proper adjustment? (See Figure 13)

Figure 13

3. Find dimensions A, B and C in Figure 14.

   A.
   B.
   C.

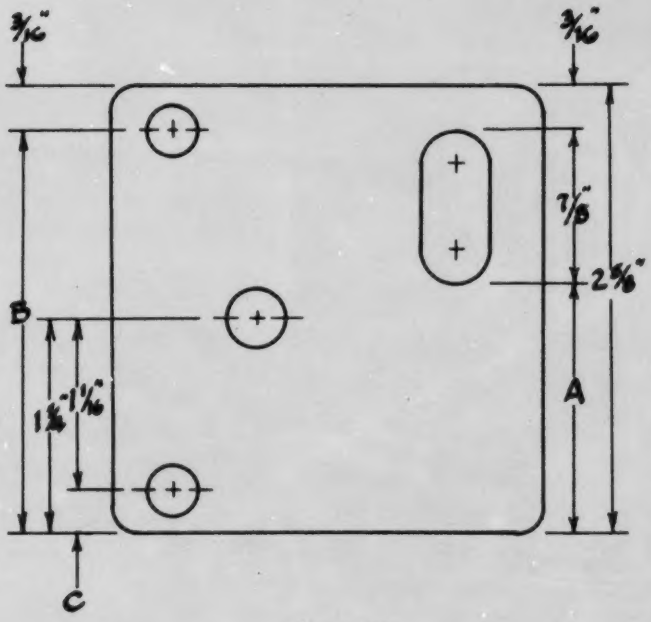


Figure 14

Answers

1. a. $27\frac{3}{8} - 18\frac{3}{4}$
   - The LCD is 8: $27\frac{3}{8} - 18\frac{6}{8}$
   - Subtract the fraction: $\frac{7-6}{8} = \frac{1}{8}$
   - Subtract the whole numbers: $27 - 18 = 9$
   - Write the results together: $9\frac{1}{8}$"

b. $36 - 18\frac{3}{4}$
- The LCD is 4
- Borrow 1 from the 36 to be able to subtract the fractions: $36 = 35\frac{4}{4}$ (writing the 1 in terms of the LCD)
- Subtract the fractions: $\frac{4}{4} - \frac{3}{4} = \frac{1}{4}$
- Subtract the whole numbers: $35 - 18 = 17$
- Write the result: $17\frac{1}{4}$

c. $42\frac{5}{16} - 18\frac{3}{4}$
- The LCD is 16: $42\frac{5}{16} - 18\frac{12}{16}$
- Borrow 1 from 42: $42\frac{5}{16} = 41 + 1\frac{5}{16} = 41\frac{21}{16}$
- Subtract the fractions: $\frac{21}{16} - \frac{12}{16} = \frac{9}{16}$
- Subtract the whole numbers: $41 - 18 = 23$
- Write the result: $23\frac{9}{16}$

d. $50\frac{9}{10} - 18\frac{3}{4}$
- The LCD is 20 $50\frac{18}{20} - 18\frac{15}{20}$
- Subtract the fractions: $\frac{18}{20} - \frac{15}{20} = \frac{3}{20}$
- Subtract the whole numbers: $50 - 18 = 32$
- Write the result: $32\frac{3}{20}$"

e. $65\frac{1}{2} - 18\frac{3}{4}$
- The LCD is 4: $65\frac{2}{4} - 18\frac{3}{4}$
- Borrow one from 65: $65\frac{3}{4} = 64 + 1\frac{3}{4} = 64\frac{7}{4}$
- Subtract the fractions: $\frac{7}{4} - \frac{3}{4} = \frac{4}{4}$
- Subtract the whole numbers: $64 - 18 = 46$
- Write the result: $46\frac{4}{4}$

2. He would move it back $\frac{8}{8} - \frac{3}{8}$ of a turn
   - The LCD is 40: $\frac{25}{40} - \frac{24}{40} = \frac{1}{40}$ of a turn

3. A would equal $2\frac{8}{8}$ minus the lengths $\frac{7}{8}$ and $\frac{9}{16}$. So first add $\frac{7}{8}$ and $\frac{9}{16}$:

$$\frac{14}{16} + \frac{9}{16} = \frac{17}{16} = 1\frac{1}{16}$$

Next subtract this dimension from the total length:

$$2\frac{8}{8} - 1\frac{1}{16} = 2\frac{16}{16} - 1\frac{1}{16} = 1\frac{9}{16}$$

B would equal $2\frac{8}{8} - \frac{9}{16} = 2\frac{16}{16} - \frac{9}{16} = 2\frac{7}{16}$
C would equal $1\frac{4}{4} - 1\frac{1}{16} = 1\frac{4}{16} - 1\frac{1}{16} = \frac{3}{16}$

Multiplication With Fractions

Multiplying numbers with fractions involves three steps:

Steps:	*Example*: $2\frac{3}{4} \times \frac{7}{8}$
1. Change any mixed numbers to improper fractions.	1. $2\frac{3}{4} = \frac{11}{4}$, so the problem becomes $\frac{11}{4} \times \frac{7}{8}$
2. Multiply together the numerators. Then multiply the denominators. Write the numerator result over the denominator result.	2. $\frac{11 \times 7}{4 \times 8} = \frac{77}{32}$
3. Change to a mixed number and reduce to lowest terms.	3. $32\overline{)77}$ $2\frac{13}{32}$ $\underline{64}$ 13

Example

In a certain week a grader operator worked 6-½ hours a day for 4-⅔ days. How many total hours did he work that week? To solve the problem, you would multiply the hours worked per day times the total days worked:

1. First, change the mixed numbers to improper fractions:

$$6\text{-}\tfrac{1}{2} = {}^{13}\!/_{2}$$
$$4\text{-}\tfrac{2}{3} = {}^{14}\!/_{3}$$

2. Next, multiply numerators together and denominators together:

$${}^{13}\!/_{2} \times {}^{14}\!/_{3} = \frac{13 \times 14}{2 \times 3} = \frac{182}{6}$$

3. Then, change the result to a mixed number and reduce it:

$$\begin{array}{r} 30\text{-}{}^{2}\!/_{6} \\ 6\overline{)182} \\ \underline{18} \\ 2 \\ \underline{0} \\ 2 \end{array}$$

Since the numerator and denominator are both divisible by 2, ⅙ can be reduced to ⅓. Therefore, the answer is 30-⅓.

a. A short-cut to this step is to use *cancellation*. This is similar to reducing fractions. Taking the fractions,

$$\frac{13 \times 14}{2 \times 3},$$

you would cancel out terms that divide into one of the numerators and one of the denominators. In this example, 14 is divisible by 2 and 2 is divisible by 2. So, you cancel 2 out of both terms:

$$\frac{13 \times \overset{7}{\cancel{14}}}{\underset{1}{\cancel{2}} \times 3} = \frac{91}{3}$$

This step simplifies your multiplication and also the next step.

b. Using the simplied, cancelled fraction, you would obtain:

$$\begin{array}{r} 30\text{-}{}^{1}\!/_{3} \\ 3\overline{)91} \\ \underline{9} \\ 1 \\ \underline{0} \\ 1 \end{array}$$

Exercises

1. An inexpensive machine component is subject to 1-¾ times as many breakdowns as the normal component used. If the breakdown rate of the normal component is 2-⅖ times per month, how many breakdowns in a month would you expect using the inexpensive component?
2. The capacity of an oil drum is 31-½ gallons. If the drum is ⅝ full, how many gallons are there?
3. A carpenter can saw through 1″ of one-inch thick pine in ⅛ of a minute. How long would it take him to cut through 12″ of pine. (A whole number can be written as a fraction by using 1 as a denominator, for example, $\frac{12}{1}$).

   The following are his times to saw 1″ of other types of lumber. Calculate the total time required to cut through the widths listed.

	Minutes Per 1″	*Width in Inches*	*Total Time Required*
Plywood	⅛	48	
Maple	⅖	10	
Oak	¾	7-⅔	
Ash	1-⅛	5-¾	
Hickory	1-⅓	12	

Answers

1. The breakdown rate would equal:

$$1\text{-}\tfrac{3}{4} \times 2\text{-}\tfrac{2}{5} = \tfrac{7}{4} \times \tfrac{12}{5} = \frac{7 \times 12}{4 \times 5} = \frac{91}{20}$$

This reduces to 4-$\frac{11}{20}$ breakdowns.

2. $$31\text{-}\tfrac{1}{2} \times \tfrac{5}{8} = \tfrac{63}{2} \times \tfrac{5}{8} = \frac{63 \times 5}{2 \times 8} = \frac{315}{16}$$

This reduces to 19-$\frac{11}{16}$ gallons of oil in a drum ⅝ full.

3. Multiply the time to cut 1″ times the total inches:

Pine: $\frac{1}{8} \times 12 = \frac{1 \times \overset{2}{\cancel{12}}}{\underset{1}{\cancel{8} \times 1}} = \frac{2}{1} =$ 2 minutes

Plywood: $\frac{1}{8} \times 48 = \frac{1 \times 48}{8 \times 1} = \frac{48}{8} =$ 6 minutes

Maple: $\frac{2}{5} \times 10 = \frac{2 \times 10}{5 \times 1} = \frac{20}{5} =$ 4 minutes

Oak: $\frac{3}{4} \times 7\text{-}\frac{2}{3} = \frac{3}{4} \times \frac{23}{3} = \frac{\overset{1}{\cancel{3}} \times 23}{4 \times \underset{1}{\cancel{3}}} = \frac{23}{4} =$

5-¾ minutes

Ash $1\text{-}\frac{1}{8} \times 5\text{-}\frac{3}{4} = \frac{9}{8} \times \frac{23}{4} = \frac{9 \times 23}{8 \times 4} = \frac{207}{32} =$

6-$\frac{15}{32}$ minutes

Hickory: $1\text{-}\frac{1}{3} \times 12 = \frac{4 \times \overset{4}{\cancel{12}}}{\underset{1}{\cancel{3}} \times 1} =$ 16 minutes

Division With Fractions

Dividing using fractions is very similar to multiplication. It involves three steps:

Steps:

1. Change any mixed numbers to improper fractions.
2. Invert the divisor. Invert means to turn upside-down.

Example: $1\text{-}\frac{2}{3} \div \frac{3}{4}$

1. $1\text{-}\frac{2}{3} = \frac{5}{3}$, so the problem becomes $\frac{5}{3} \div \frac{3}{4}$
2. Invert ¾ to ⅘

3. Using the inverted divisor, proceed as if it was a multiplication problem.

3. a. $\frac{5}{8} \div \frac{3}{4}$ is the same as $\frac{5}{8} \times \frac{4}{3}$

b. $\frac{5 \times 4}{3 \times 3} = \frac{20}{9}$

c. $9\overline{)20}$ $\quad 2$ The result is $2\frac{2}{9}$

$\underline{18}$

2

Example

A 72" steel bar is to be cut into 3-$\frac{5}{16}$" lengths. An apprentice determines how many pieces she can cut from the bar using the following steps.

1. She sets up the problem as:

   72" ÷ 3-$\frac{5}{16}$" per piece = total number of pieces

2. Then, converting mixed numbers to fractions:

$$\frac{72}{1} \div \frac{53}{16}$$

3. Next, the apprentice inverts the divisor:

$$\frac{72}{1} \div \frac{53}{16} = \frac{72}{1} \times \frac{16}{53}$$

4. And she calculates the result:

$$\frac{72 \times 16}{1 \times 53} = \frac{1152}{53}$$

$$\begin{array}{r} 21 \\ 53\overline{)1152} \\ \underline{106} \\ 92 \\ \underline{53} \\ 39 \end{array}$$

21 total pieces could be cut from the bar

Exercises

1. The cutting tool on a lathe is set to move automatically $\frac{7}{8}$" every minute. How long would the turning of a 12-$\frac{3}{8}$" rod take?

2. For each $\frac{1}{2}$ turn of a small gear, a large gear moves $\frac{1}{8}$ of a turn. How many times would the small gear rotate for one full turn of the large gear?

3. The following lengths of sheet metal are to be cut into equal sized pieces. Calculate the total number of pieces that can be cut from each length.

	Total Length	*Length Per Piece*	*Number of Pieces Per Length*
a.	48"	2-⅔"	
b.	25-⅞"	6-¼"	
c.	17-⅛"	½"	
d.	64-⅔"	2-⅓"	

Answers

1. The time required would equal the total length divided by the length moved each minute:

$12\text{-}\frac{2}{3} \div \frac{7}{8} = \frac{38}{3} \div \frac{7}{8} = \frac{38}{3} \times \frac{8}{7} = \frac{38 \times 8}{3 \times 7} = \frac{304}{21} = 14\text{-}\frac{10}{21}$ minutes.

2. The number of turns would equal the amount moved by the small gear divided by the amount moved by the large gear:

$$\frac{1}{2} \div \frac{1}{8} = \frac{1}{1} \times \frac{4}{1} = 4 \text{ turns}$$

3. a. $48'' \div 2\text{-}\frac{2}{3}'' = \frac{48}{1} \div \frac{8}{3} = \frac{48 \times 3}{1 \times 8} = \frac{6}{1} = 18$ lengths

b. $25\text{-}\frac{7}{8}'' \div 6\text{-}\frac{1}{4}'' = \frac{207}{8} \div \frac{25}{4} = \frac{207}{8} \times \frac{4}{25} = \frac{207}{50} = \frac{1}{2} = 4$ lengths

c. $17\text{-}\frac{1}{5}'' \div \frac{1}{2}'' = \frac{86}{5} \div \frac{1}{2} = \frac{86}{5} \times \frac{2}{1} = \frac{172}{5} = 34$ lengths

d. $64\text{-}\frac{2}{3}'' \div 2\text{-}\frac{1}{3}'' = \frac{194}{3} \div \frac{7}{3} = \frac{194}{3} \times \frac{3}{7} = \frac{194}{7} = \frac{1}{27}$ lengths

Decimal Fractions

Decimals are fractions whose denominators are multiples of 10, that is 10, 100, 1000, and so on. Instead of writing the denominator, its value is indicated by the position of a *decimal point*. For example, $\frac{9}{10}$ is written as .9 and said "nine-tenths." Also, $\frac{33}{100}$ is .33, meaning thirty-three one-hundredths. The rules for writing decimals are the following:

- Only the numerator of the fraction is written.
- A decimal point indicating the value of the denominator precedes the numerator of the fraction.
- The number of zeros in the denominator determines the number of place values to the right of the decimal.

To write $^{9}/_{100}$, we would:

1.	Write the numerator.	9
2.	Place a decimal point.	.9
3.	Determine the number of place values—this is 2 since 100 has 2 zeros. So, we have to insert a place holder, which is 0.	.09

To write $^{27}/_{10,000}$, we would:

1.	Write the numerator.	27
2.	Place a decimal point.	.27
3.	Add 2 place holders (so we have a total of 4 digits).	.0027

How would you write the following fractions as decimals?*

a. $^{17}/_{100}$ b. $^{3}/_{10}$ c. $^{2}/_{1000}$ d. $^{437}/_{1000}$

Changing Fractions To Decimals

Oftentimes it is necessary to change the results of your calculations to decimals so the results will be consistent with measures or other figures that are expressed in decimals. For example, suppose you calculated that the length of a particular rod was to be $^{17}/_{20}$". Using a machinist's scale, which is divided into hundredths, it would be impossible to make the necessary measurement. Therefore, you must be able to change your result to a decimal for this and many other applications.

To convert a common fraction to a decimal fraction, divide the numerator by the denominator. This is done by following these steps:

Steps:	*Example*: $^{17}/_{20}$
1. Set up the division problem as you learned in the last unit.	20)17
2. Place a decimal point after the number under the sign. Then put a zero next to the decimal. Placing zeros to the right of the decimal does not change the value of a number. But it does enable you to divide a larger number into a smaller one.	20)17.0
3. Place the decimal point above the sign in the same position it is beneath the sign.	20)17.0
4. Divide as you would with whole numbers. Add zeros to continue the operation until there is no remainder.	.85 20)17.00 16 0 1 00 1 00

* *Answers:*
a. .17 b. .3 c. .002 d. .437

Change the following fractions to decimals:*

a. $\frac{3}{5}$ b. $\frac{3}{8}$ c. $\frac{14}{40}$ d. $\frac{1}{25}$

Rounding Decimals

Sometimes in changing a fraction to a decimal you will find that no matter how many zeros are added you still have a remainder. Take for example the fraction $\frac{1}{3}$:

```
   .3333
3)1.0000
  9
  --
  10
   9
  --
  10
   9
  --
  10
   9
  --
   1
```

As you can see, the division process would go on forever. So, in cases such as this, you need to stop dividing when your answer has a desired amount of accuracy. The more decimal places in the answer, the greater the accuracy will be. If you are dealing with micrometer measurements, you may need accuracy to three decimal places (thousandths). When working with a ruler, tenths may be accurate enough for your purposes.

Based on the degree of accuracy you need in an answer, you can *round the number to the nearest decimal.* Rounding involves the following steps:

Steps:	*Examples*:
1. Drop all of the digits to the right of your desired cut-off point.	a. Round .33333333 to the nearest thousandths b. Round .4567 to the nearest hundredths
2. Compare the digit to the right of the number you saved with the number 5.	
a. If it is less than 5, retain the number as you have it	a. .333
b. If it is equal to or greater than 5, add one to the last digit in your retained number.	b. .46

* *Answers*

a. .6 (5)3.0

b. .375 (8)3.0; 24; 60; 56; 40; 40

c. .35 (40)14.00; 120; 200; 200

d. .04 (25)1.00; 100

Example

A 2" metal rod was to be taken down to ⅝ of its diameter. This would be:

$$\frac{\overset{1}{\cancel{2}}}{1} \times \frac{5}{\underset{3}{\cancel{6}}} = \frac{5}{3} = 1\frac{2}{3}".$$

The accuracy of the finished product would be checked with a micrometer. Therefore, it was necessary to change the final diameter to a decimal fraction, accurate to three decimal places. The apprentice solving the problem used the following steps:

1. First, he set up the problem as a division problem:

   $3\overline{)2.0}$

2. He added a decimal point and zero to start the division

3. Next, a decimal point was placed above the sign and the apprentice proceeded with the division problem. He added 4 zeros so that he would have enough digits to round his answer to 3 places.

```
   .6666
3)2.0000
  18
  --
  20
  18
  --
  20
  18
  --
  20
  18
  --
   2
```

4. The final step was to combine the decimal fraction with the whole number and round 1.6666 to the nearest thousandths. He kept 1.666. Since the next digit (6) was greater than 5, the number was rounded up to 1.667. Therefore, the diameter to check was 1.667".

Exercises

1. The following measurements are expressed as common fractions. Change the measurements to decimal form and round them as instructed.
   a. 3/16", round to the nearest thousandth
   b. 2-5/8", round to the nearest hundredth
   c. 5-7/8", round to the nearest tenth
   d. 17-9/16', round to the nearest thousandth

2. In exercise d above, you were instructed to round 17-9/16' to the nearest thousandth. Does this seem like an unusual request? Why?

Answers

1. a. 3/16 = .1875 = .188
   b. 2-5/8 = 2.625 = 2.63
   c. 5-7/8 = 5.87 = 5.9
   d. 17-9/16 = 17.5625 = 17.563

2. This is an unusual request because the measurement is in feet. You generally do not require such high accuracy as thousandths when you are working with such large measures as feet.

Addition And Subtraction Using Decimals

Adding and subtracting decimals follow the same rules or steps that apply to working with whole numbers. But you must be careful to *line up the decimals of each figure* when you set up the problem. This assures that all the place values will be lined up.

Example

Various components of a product weigh .345 lb, 2.1 lb, .012 lb, 13 lb, and .07 lb. What will be the total weight of the assembled product?

To solve this problem, set up the figures in a column, aligning the decimals.

```
  .345
 2.1
  .012
13.
  .07
 ----
  ↑
Line up
decimals
```

To make addition easier you may fill in the blank spaces with zeros. This does not change any of the values.

```
 00.345
 02.100
 00.012
 13.000
+00.070
```

Next, proceed with addition. Numbers may be carried and borrowed just as they are in adding and subtracting whole numbers.

```
 00.345
 02.100
 00.012
 13.000
+00.070
 ------
 15.527  lb
```

Exercises:

1. A metal bar is 8.167 cm wide. If the desired width of the bar is 7.85 cm, how much should be removed?

2. The prices of supplies needed to install a gutter on portions of a roof are listed below. What will be the total cost of the supplies?

3	ten-foot gutter sections @ $5.99 each	$17.97
2	caps @ $.49 each	.98
2	corners @ $2.69 each	5.38
1	drop outlet	2.49
1	elbow	1.19
1	downspout	6.49
1	can touch-up paint	2.79
2	tubes caulk @ $1.99 each	3.98

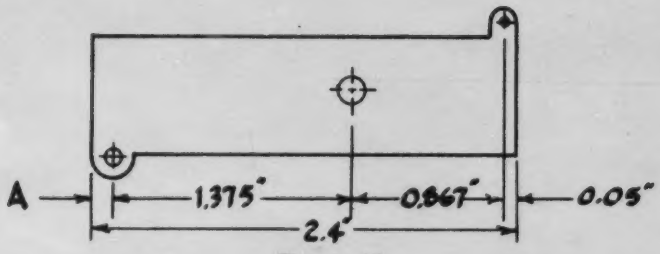


Figure 15

3. Refer to the drawing in Figure 15. What is the length of dimension A?

Answers

1.
$$\begin{array}{r} 8.167 \\ -\ 7.850 \\ \hline .317 \text{ cm} \end{array}$$

2.
$$\begin{array}{r} 17.97 \\ .98 \\ 5.38 \\ 2.49 \\ 1.19 \\ 6.49 \\ 2.79 \\ +\ 3.98 \\ \hline \$41.27 \end{array}$$

3. Dimension A would equal the total length minus the sum of the remaining dimensions. First, add the length segments:

$$\begin{array}{r} 11 \text{ — } \textit{Carries} \\ 1.375 \\ .867 \\ +\ .050 \\ \hline 2.292 \end{array}$$

Then, subtract this from the total:

$$\begin{array}{r} 39 \\ 2.400 \\ -2.292 \\ \hline .108'' \end{array}$$

Multiplying And Dividing With Decimals

Multiplication with decimals is the same process as used with whole numbers. However, you must pay particular attention to placing the decimal point in your answer. This involves two steps:

Steps:

1. Count the number of digits to the right of the decimals in both of the numbers you are multiplying. Total them.

2. In the answer, count from the right of the total number of digits you counted above. Place the decimal there.

Example:

$$\begin{array}{rl} 4.67 & \textit{2 digits} \\ \times\ 3.5 & +\ 1 \text{ digit} \\ \hline 2335 & 3 \text{ digits} \\ 1401 & \\ \hline 16345 & \end{array}$$

16.345 — 3 digits

Division is also the same as with whole numbers, but the trick is in placing the decimal point. If the only decimal point in the problem is under the division sign, then simply place the decimal in the answer directly above the point under the sign.

Example: $12\overline{)24.782}$

Line up the decimals when the only decimal is under the sign.

If the divisor has a decimal, the process is a little more complicated, but not too bad. Follow these steps:

Steps:	*Examples:*
1. Count the number of digits to the right of the decimal in the divisor.	1. a. $12.12\overline{)24.782}$ (2 digits) b. $.12\overline{)24}$ (2 digits)
2. Count that number of digits to the right of the decimal in the number under the sign. Add zeros if there are not enough places. That is where the decimal in the answer is placed.	2. a. $12.12\overline{)24.782}$ b. $.12\overline{)24.00}$

Example

A metal plate is 16.5 cm in length. Holes are to be drilled in the plate at a distance of 1.45 cm on center. Is the plate large enough for 10 holes?

To solve this problem first make a rough sketch of the problem, as in Figure 16. You want each of the distances, D, to equal 1.45 cm.

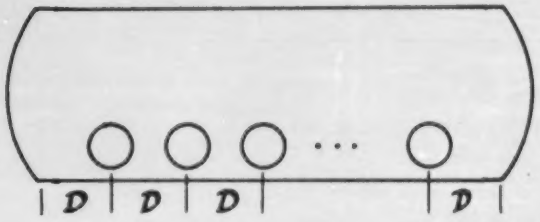


Figure 16

Next, find out how many D's you have in the total length. You do this by dividng 16.5 by 1.45. To fit 10 holes on the plate you need at least 11 D's. This is because there is a D at each end of the plate. Draw in 10 holes and count the D's to see how this works.

The results of the division gives the following:

```
      11.379
1.45)16.50 000
     14 5
     -----
      2 00
      1 45
     -----
       55 0
       43 5
     -----
       11 50
       10 15
     -----
        1 350
        1 305
     -----
```

There are 11 distances (D's) on the plate so the holes will fit. By continuing the division, you can determine how much excess length there is. Two-digit accuracy is sufficient for our purposes. .379 can be rounded to .38 cm, which is the amount of excess.

Exercises

1. The following work order is to cut aluminimum rods into equal length segments. Determine how many segments you could cut from each rod. Also, find the amount of scrap, by continuing the division, and round to 2 places.

	Rod Length	*Length Per Segment*	*Total Segments*	*Scrap*
a.	62.85 cm	12.5 cm		
b.	48 in	5.685 in		
c.	12 ft	1.8 ft		
d.	120.5 cm	10 cm		

Figure 17

2. The outside diameter of a pipe is 2.46". The inside diameter is 2.275". a. What is the difference between the inside and outside diameters? b. What is the thickness of the pipe? (See Fig. 17).

3. The diameter of the head on a countersunk screw is 1.74 times the diameter of the screw. a. If the diameter of the screw is .435 cm, what is the diameter of the head? b. What would be the diameter of the head if the screw were .265 cm in diameter? Round your answers to three places.

Answers

1.

	Result of Division	*Total Segments*	*Scrap*
a.	5.028	5	.03 of a segment
b.	8.443	8	.44 of a segment
c.	6.666	6	.67 of a segment
d.	12.05	12	.05 of a segment

2. a.
$$\begin{array}{r} 35 \\ 2.460 \\ -2.275 \\ \hline .185 \end{array}$$

b. The thickness of the pipe is ½ of the difference between the diameters. If you do not understand this, look closely at Figure 17. By subtracting the diameters, we find the measurement of 2 thicknesses.

$$.185 \times \frac{1}{2} = \frac{.185}{2} = .0925''$$

3. a. $.435 \times 1.74 = .75690 = .757$
b. $.265 \times 1.74 = .46110 = .461$

Using Percents

Percents are special types of fractions where the denominator of the fraction is 100. Instead of writing the denominator as 100, a percent sign is used. For example:

$12/100$ = 12 percent or 12%
$50/100$ = 50 percent or 50%
$2/10$ = $20/100$ = 20 percent or 20%
$3/5$ = $60/100$ = 60 percent or 60%

Percents are used often in most work situations. For example, a supervisor may request, "Give me 80% power." Or you may be asked, "What percent of that is scrap." You may complain each week that the government takes 25 percent of your paycheck (or even more).

Generally, there are three different calculations you may need to perform with percents.

1. Change common or decimal fractions to percents.
2. Calculate a percentage of a total amount.
3. Determine what percent an amount is of a total amount.

Change Fractions to Percents

It is easy to work with percents because they have a built-in common denominator. Therefore, it is simple to make comparisons and to perform basic operations. For example it is clear that 60% is greater than 58%. Would it be that easy to see that $3/5$ is greater than $29/50$?

To change fractions to percents, first put them in decimal form, then:

- Move the decimal two places to the right
- Add a percent sign

To change a percent to a fraction:

- Move the decimal two places to the left, adding zeros if necessary
- Drop the percent sign
- Change to a common fraction if you like

Examples

.23 = 23%
.476 = 47.6% or 47-⅗%
⅗ = .60 = 60%
18% = .18
25% = .25 or ¼

Exercises

1. A fuel gauge reads ¾ full. What percent of the fuel has been burned?
2. Listed below are the hours that various production machines were not operating in a 24-hour day. What is the percentage of time that each of the machines was down in a day? Round your decimals to the nearest hundredths.

Machine	*Hours down*	*% Down time*
1	2	
2	.5	
3	3.6	
4	8	

Answers

1. Change ¾ to a decimal:

$$
\begin{array}{r}
.75 \\
4\overline{)3.00} \\
28 \\
\hline
20 \\
20 \\
\hline
\end{array}
$$

Therefore, the tank is 75% full. To find out how much has been burned, subtract the amount remaining from the total capacity (100%):

100 − 75 = 25% of the fuel has been burned

2. To find % down time, divide hours down by total hours (24), and move the decimal 2 places to the right.

Machine	*% Down Time*
1	8.33 %
2	2.08 %
3	15.00 %
4	33.33 %

Calculate Percentage of a Total Amount

Oftentimes it will be necessary to compute a percentage of a number. For example, in ordering raw materials you frequently will have to include an additional percentage for waste allowance. Calculating amount of sales tax is another example of taking a percentage of a total.

Wherever you have a problem that involves determining a certain percentage of a total amount, use the following steps:

1. Convert the percentage to a decimal.
2. Multiply the decimal times the total amount.

Example

A parts catalog advertised a 20% savings on all the company's merchandise. To calculate what the savings would be on an order of $128.95, you would:

1. Change 20% to .20 or .2
2. Multiply:
3. Count off 3 places from right in answer and place decimal there.

```
  1 1 1   ← Carries
 128.95
×  .2
--------
$25.790
```

The savings would be $25.79

Exercises

1. The employees listed below each pay 6.6% of their weekly earnings to social security. How much do they pay per week?

Employee	*Weekly Earnings*	*Social Security Payment*
Howard	$ 435.86	
Engles	$ 298.42	
Johnson	$ 347.33	
Murdock	$ 369.27	

2. Two companies had comparable 5-piece sets of drawing instruments on sale. One company originally priced the sets at $39.95 and was offering a 25% reduction. The second company had a 30% reduction, but the sets were originally $42.50. Which company offered the lowest sale price?

Answers

1. First, change 6.6% to a decimal—.066. Multiply weekly earnings by .066 to get the SS payment.

Employee	*Social Security Payment*
	$28.77
Howard	$19.70
Engles	$22.92
Johnson	$24.37
Murdock	

The answers are rounded to hundredths of dollars since that is the smallest American currency (cents).

2. The first company's reduction is \$39.95 times .25 which equals \$9.99. So, the sales price is \$39.95 − 9.99 = \$29.96. For the second company the reduction is \$42.50 × .30 = \$12.75. The sales price is \$42.50 − 12.75 = \$29.75. The second company had the lower price.

Determine What Percent An Amount Is

A third frequent use of percentages is to find out what percent one amount is of another. This is what you do to figure out what percent of your paycheck goes to the government. To determine the percent in this case, you would first divide the amount taken out by the total amount and then change the resulting decimal to a percent. This is the same way you would handle all similar problems:

1. Form a fraction by putting the part over the total amount.
2. Divide the fraction to change it to a decimal.
3. Change the decimal to a percent.

Example

The basement in a set of house plans is 900 square feet. The total area of the house is 2600 square feet. Assuming the basement will not be heated, what percentage of the house will be heated space?

To solve this, first determine how many square feet will be heated. This is found by subtracting the unheated area from the total area:

$$\begin{array}{r} 2600 \\ -900 \\ \hline \end{array}$$

1700 heated square feet

Next create a fraction by putting the heated area over the total area: $\frac{1700}{2600}$ (cancelling out 100).

Dividing, you would find the decimal equivalent:

$$\begin{array}{r} .6538 \\ 26\overline{)17.0000} \\ 15\,6 \\ \hline 1\,40 \\ 1\,30 \\ \hline 100 \\ 78 \\ \hline 220 \\ 208 \\ \hline \end{array}$$

And lastly, change the decimal to a percent:

.654 = about 65% of the house would be heated space.

Exercises

1. The total production and amount of scrap produced by four machines is listed below. Which machine produced the highest percentage of scrap? Round answers to the nearest tenths.

Machine #1	*Total Production*	*Scrap*	*% Scrap*
1	5433	389	
2	1794	180	
3	4876	340	
4	3944	295	

2. A painter had three gallons of paint, each of which would cover 420 square feet of area. If the job was 1800 square feet, what percentage of the job could the painter finish with the paint on hand?

Answers

1. Percent scrap is calculated by dividing scrap by the total production and moving the decimal two places to the right.

Machine #	*% Scrap*
1	7.2
2	10.0
3	7.0
4	7.5

2. The total space the painter could paint is 420 square feet/gallon times 3 gallons = 1260 sq. ft. To determine the percentage of the job this would complete, divide 1260 by 1800 and convert to %.

$$\frac{1260}{1800} = .7 = 70\%$$

Self-Test Exercises

Answer the following questions and problems. Check your answers with those in the Appendix. If you answer less than 7 items correctly, repeat your work in this chapter. If you answer 7 or 8 of the problems or questions correctly, you have mastered the use of fractions in solving problems. Go on the the next chapter.

Refer to Figure 18 to answer questions 1-4.

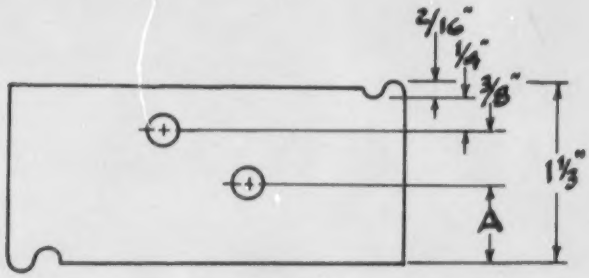


Figure 18

1. Determine the dimension A, reducing to lowest terms.
2. Convert A to a decimal fraction. Round to nearest thousandth.

3. If you had a work order to produce the plate at ⅔ of its size in Fig. 18, what would be the size of dimension A?

4. What percent of its full size would this reduction be?

Use the following situation to answer questions 5 and 6.

A landscaper needed the following supplies:

	Catalog Price
12 dozen leaf bags	$3 99 per dozen
50# 8-8-8 fertilizer	8.50
100 feet mulch sheeting	3.98
25 feet border wire	8.79
motor oil	5.65

5. What is the total cost of the supplies?

6. Being a regular customer, the landscaper receives a 20% discount off the regular catalog prices for most supplies. What will be his reduced price for the 50# of fertilizer?

7. Each setting on a control moved a cutting blade .175 inches. How many settings would an operator need to adjust the control to move the blade a total of 2.275 inches?

8. Eight-foot pine planks measuring 5-¾" wide are to be used to panel an 8 foot by 8 foot wall. Assuming that the panels will overlap by ½", how many planks will be needed to panel the wall? (8 feet is equal to 96 inches).

4. Formulas And Tables

Chapter Overview

Purpose:	To develop skills in using trade-related tables and formulas. An apprentice will gain an understanding of how formulas represent rules and relationships and an ability to determine values of unknowns using formulas and tables.
Preassessment Score:	Write in the following space the number of correct answers from Pretest questions 17-22: _____ . If you answered five or six questions correctly, skip to the Posttest in the Appendix. If you missed two or more questions, work through this chapter.
Prerequisites:	Chapter 1 of this booklet. Chapters 2 and 3 of this booklet or mastery of the four basic arithmetic operations using whole numbers, fractions, decimals and percents.
Resources:	Time—About 1-1½ hours to complete. Materials—paper, pencil
Performance Measure:	A thirty-minute paper-and-pencil Posttest, to be taken after completing the entire booklet.
Standards:	To be successful, you must answer correctly 80% of the Posttest items.
Activities:	1. Read the text, examples and illustrations and commit information to memory. 2. Work questions, examples and problems. 3. Complete and check the Self-Test Exercises and the Posttest.

Introduction And Objectives

Formulas and tables are ways of showing relationships among the parts of a problem. A formula is written to describe the rules governing various calculations. For example, the diameter of a circle is equal to twice the radius of the same circle. This general rule could be written as:

$$D = 2 \times r$$

where D is the diameter and r is the radius. Then if you had a circle whose radius was 3", you could solve for the diameter:

$$D = 2 \times 3'' = 6''$$

Another way this relationship could be represented is in a table:

D = 2 × r	
D	**r**
2	1
4	2
6	3
8	4
10	5
12	6

In this case, values of r are listed along with the associated value of D. Rather than compute the value of D as you did with the formula, you would look in the table. First, you would read down the column marked r until you find the appropriate value (3). Then reading across to the associated value of D, you would find it to be 6.

Both formulas and tables are very useful tools in most trades. They show relationships among such things as:

- Pitch of a screw and threads per inch
- Length, width and area of a floor plan
- Inches and centimeters
- Resistance, current and voltage in a circuit
- Gravel, sand and cement mix
- Feed, cutting speed and diameter of milling cutters

As you work through the unit, you will most likely recognize a number of opportunities where you can make use of formulas and tables in your work. After completing the chapter you will demonstrate your competence by being able to:

1. Write formulas to represent rules and relationships.
2. Solve formulas for unknowns.
3. Read tables to determine the value of an unknown.

Writing Formulas For Rules

Writing rules or relationships as formulas involves assigning letters or symbols to the quantities and combining them into an expression. The steps for writing formulas are listed below, using the following relationship as an example:

The area of a triangle is equal to one-half of the base of the triangle times the height of the triangle.

Steps:

1. Identify the quantities that are involved in the relationship.

Example:

1. In the example the rule describes a relationship among:
   a. area
   b. base
   c. height

2. Assign letters or symbols to represent unknown amounts of the quantity. Use standardized terms if you are aware of any. A useful rule is to use the first letter of the quantity.

2. For each of the quantities you would assign:

   area — A
   base — b
   height — h

   These are standard terms as well as the first letters of the quantities.

3. Define the operations that are involved. It is often useful to draw an illustration such as Figure 19 to help you picture the relationships.

3. First, draw a figure to show the relationship:

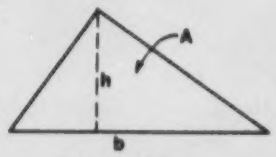


Figure 19

A formula would define the relationship between (1) the area (A) of a triangle and (2) its base and height (b,h). Operations involved are:

- taking ½ of the base, which means ½ × b
- multiplying this times the height

4. Write the formula form. Use the equals sign to separate one quantity from those it is being related to.

4. First, write from Step 3:

   A =

   Then, on the right side of the equals sign, write the other quantities and operations involved:

   A = ½ × b × h

Writing a problem in formula form can be useful to you for two reasons:

1. The process helps you define in your own mind what calculations will be involved in solving the problem.
2. Once you have written the formula, often you can use it to solve future problems involving the same quantities and unknowns.

The example which follows will show you one way formulas can be used.

Example

An apprentice needed to determine the total distance around a house site to plan for laying the footings. From the floor plans for the house, he found the dimensions in Figure 20.

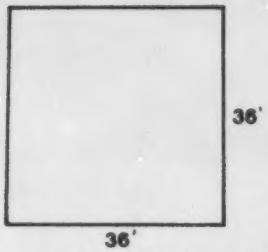


Figure 20

So, to find the distance around or the *perimeter* of the planned house, he added up the lengths of the sides: 36′ + 36′ + 36′ + 36′ = 144′.

In doing this, the apprentice noticed that this was equal to 4 × 36′ = 144′. A more general rule from this problem is that the perimeter of a square (because it has equal length sides) is equal to 4 times the length of one side. This can be written as P = 4 × S. This formula can be used to determine the perimeter of *any* square, by simply measuring the length of one side and substituting this in place of S in the formula.

Exercises

Write a formula for each of the relationships below.

1. The gas mileage of an automobile is equal to the number of miles traveled divided by the number of gallons used.

2. The number of feet is equal to the number of inches divided by 12.

3. The perimeter of a rectangle is equal to 2 times the length of the rectangle plus 2 times the width of the rectangle.

4. One kilogram equals 2.2 pounds. (This could also be written: the number of pounds equals 2.2 times the number of kilograms).

Answers

1. MPG = m/g
2. f = i/12
3. P = (2 × l) + (2 × w). The parentheses mean that you would do the multiplication operations before you add the results together.
4. p = 2.2 × k

Solving Formulas For Unknowns

Once a formula is written, you are able to solve for unknowns by substituting values of known quantities in the formula. Look at the formula for the area of a triangle:

$$A = \frac{1}{2} \times b \times h.$$

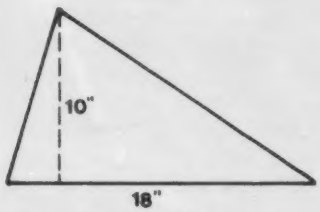


Figure 21

If you measured the dimensions in Figure 21, you could solve for the area of the triangle. First, substitute the known values of 18 for b and 10 for h in the formula:

$$A = \frac{1}{2} \times 18 \times 10.$$

This allows you to *solve for the unknown* quantity A by performing the calculations:

$$A = \frac{1}{2} \times 18 \times 10$$

$$A = \frac{1}{2} \times 180 = 90 \text{ square inches}$$

Example

A builder faced the problem of raising a number of fixtures to the second floor of a construction job. She decided to rig up a pulley system to move the fixtures. The number of strands in the pulley system is equal to the load divided by the amount of force that can be applied to lift the weight. So she had a formula:

$$N = \frac{W}{F}$$

N = Number of ropes
W = Weight of load
F = Force applied

Drawing a figure of the problem would produce something like Figure 22.

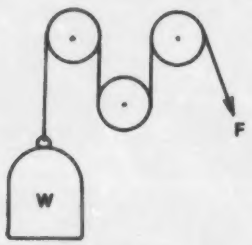


Figure 22

Since the builder knew the heaviest fixture weighed 275 pounds, she had a value for W. She assumed that the force applied by someone pulling on the ropes would be 75–100 pounds. Therefore she tried both of these values for F:

For F = 75:

$$N = \frac{275}{75}$$

N = 3.67 or about 4 ropes

For F = 100:

$$N = \frac{275}{100}$$

N = 2.75 or about 3 ropes

So the builder could rig a pulley using 3 or 4 ropes, depending on the strength of the person moving the fixtures.

Exercises

1. The voltage (E) in an electrical circuit is equal to the current times the resistance. This is written as $E = I \times R$. What voltage is required for a circuit with a resistance of 15 ohms (R) and a current of 3 amperes (I).
2. Use the formulas you wrote in the last set of exercises to solve the following:
   a. Calculate mileage for:
      miles = 247.6
      gallons = 8.5
      (Round to the nearest hundredth)
   b. How long in feet is a 36" rule?
   c. Find the perimeter of the rectangle in Figure 23.

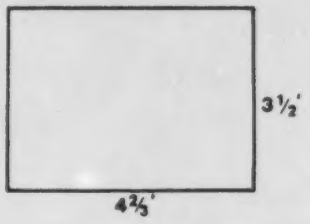


Figure 23

   d. What would be the weight in pounds of a 3½ kg component?

Answers

1. $E = I \times R$: $I = 3$, $R = 15$
   $E = 3 \times 15$
   $E = 45$ volts

2. a. $MPG = m/g$
      $MPG = 247.6/8.5$
      $MPG = 29.13$ miles per gallon

   b. $f = 36/12$
      $f = 3$ feet

   c. $p = (2 \times l) + (2 \times w)$
      $p = (2 \times 4\text{-}2/3) + (2 \times 3\text{-}1/2)$
      $p = (2 \times 14/3) + (2 \times 7/2)$
      $p = (28/3) + 7$
      $p = 9\text{-}1/3 + 7 = 16\text{-}1/3'$

   d. $p = 2.2 \times k$
      $p = 2.2 \times 3\text{-}1/2$
      $p = 2.2 \times 3.5$
      $p = 7.70$ pounds

Reading Tables

Tables present values of quantities in a relationship. Therefore, you can look up values of known quantities in the table to identify the associated value of an unknown. This is an alternative to solving for an unknown when (1) an appropriate table is available and (2) when you don't have a formula relating quantities. Using the area of a triangle as an example (see Figure 24), steps for reading a table are presented below.

Steps:

1. Identify the known values of quantities.

Example:

1. You want to find the area of a triangular foyer. You measure the dimensions of 6 ft. and 9 ft. b = 6; h = 9.

2. Find the value of one of the known quantities on the table. This could involve reading across or down a row or column.
3. Find the values of other known quantities in the same manner.
4. Find the associated value of the unknown.

2. Look for values of 6. They run down the left column of the table. Read down the column until you find 6.
3. h runs across the top of this table. Read across until you find 9. There are only 2 known values in this example, but other tables may have more.
4. To find the value for the area, identify where the associated b and h values cross or intersect. On the table, run your finger across the row where b is 6. Run your other hand down the column where h is 9. They cross at a point where the value is 27. This is the area of the triangle.

Table of Values for A = ½ b × h

b \ h	1	2	3	4	5	6	7	8	(9)
1	.5	1	1.5	2	2.5	3	3.5	4	4.5
2	1	2	3	4	5	6	7	8	9
3	1.5	3	4.5	6	7.5	9	10.5	12	13.5
4	2	4	6	8	10	12	14	16	18
5	2.5	5	7.5	10	12.5	15	17.5	20	22.5
(6)	3	6	9	12	15	18	21	24	(27)
7	3.5	7	10.5	14	17.5	21	24.5	28	31.5
8	4	8	12	16	20	24	28	32	36
9	4.5	9	13.5	18	22.5	27	31.5	36	40.5
10	5	10	15	20	25	30	35	40	45
11	5.5	11	16.5	22	27.5	33	38.5	44	49.5

Figure 24. Sample Table of Values for the Area of a Triangle

Exercises

Substitute the values of b = 6 and h = 9 in the formula for area to verify that the table gave us the correct answer. Using Figure 24, find the area of triangles with the following measurements:

	b	h	A
1.	2″	7″	
2.	8″	3″	
3.	5″	8″	

Check you answers by using the formula for area.

Answers

$A = \frac{1}{2} \times b \times h$

$A = \frac{1}{\cancel{2}} \times \overset{3}{\cancel{6}} \times 9$

$A = 27$ square feet

1. 7 $A = \frac{1}{\cancel{2}} \times \overset{1}{\cancel{2}} \times 7 = 7$ square inches

2. 12 $A = \frac{1}{\cancel{2}} \times \overset{4}{\cancel{8}} \times 3 = 12$ square inches

3. 20 $a = \frac{1}{\cancel{2}} \times 5 \times \overset{4}{\cancel{8}} = 20$ square inches

Reading the Table Backwards

You can also use the table to find the value of b or h. Take for example a situation where you know the area and one dimension of a triangle. This could be a job where you are commissioned to build a triangular-shaped pool of 28 square feet. Assuming that you are limited to one side of 7 feet, you need to determine the other dimension. This problem is illustrated in Figure 25.

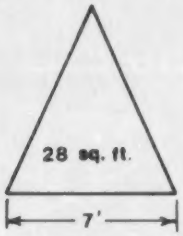


Figure 25

To find the height, first find the value b = 7 ft in the table. Reading across that row, you find the area of the pool—28 sq ft. The appropriate height for the triangluar pool is found by reading up the column from 28. You read the value of h to be 8 ft.

Exercises

Find the value of h for the following triangles:

	b	*A*	*h*
1.	3 ft	10.5 sq ft	
2.	8 ft	12 sq ft	
3.	9 ft	22.5 sq ft	

Answers

1. 7 ft
2. 3 ft
3. 5 ft

Other Table Formats

Tabular information can be presented in a number of different formats. But the steps you would follow to read the tables are basically the same. The values for area of a triangle are

presented in two different ways in Figures 26 and 27. An example is shown in each of the tables for locating area when b = 5 and h = 3.

Exercises

After looking at the examples, find the areas of the following triangles:

Using Figure 26:

	b	*h*	*A*
1.	1′	5′	
2.	4′	2′	
3.	7′	3′	

Table of Values for A = 1/2 b × h

b	h	A	b	h	A	b	h	A	b	h	A	b	h	A
1	1	.5	1	2	1	1	3	1.5	1	4	2	1	5	2.5
2	1	1	2	2	2	2	3	3	2	4	4	2	5	5
3	1	1.5	3	2	3	3	3	4.5	3	4	6	3	5	7.5
4	1	2	4	2	4	4	3	6	4	4	8	4	5	10
5	1	2.5	5	2	5	5	3	7.5	5	4	10	5	5	12.5
6	1	3	6	2	6	6	3	9	6	4	12	6	5	15
7	1	3.5	7	2	7	7	3	10.5	7	4	14	7	5	17.5
8	1	4	8	2	8	8	3	12	8	4	16	8	5	20
9	1	4.5	9	2	9	9	3	13.5	9	4	18	9	5	22.5
10	1	5	10	2	10	10	3	15	10	4	20	10	5	25
11	1	5.5	11	2	11	11	3	16.5	11	4	22	11	5	27.5

Figure 26. Sample Table (#2) of Values for the Area of a Triangle

Using Figure 27:

	b	*h*	*A*
4.	3″	2″	
5.	4″	4″	
6.	6″	1″	

Table of Values for A = 1/2 b × h

h = 1		h = 2		h = 3		h = 4		h = 5	
b	A	b	A	b	A	b	A	b	A
1	.5	1	1	1	1.5	1	2	1	2.5
2	1	2	2	2	3	2	4	2	5
3	1.5	3	3	3	4.5	3	6	3	7.5
4	2	4	4	4	6	4	8	4	10
5	2.5	5	5	5	7.5	5	10	5	12.5
6	3	6	6	6	9	6	12	6	15
7	3.5	7	7	7	10.5	7	14	7	17.5
8	4	8	8	8	12	8	16	8	20
9	4.5	9	9	9	13.5	9	18	9	22.5
10	5	10	10	10	15	10	20	10	25
11	5.5	11	11	11	16.5	11	22	11	27.5

Figure 27. Sample Table (#3) of Values for the Area of a Triangle

Answers

1. 2.5 sq ft
2. 4 sq ft
3. 10.5 sq ft
4. 3 sq in
5. 8 sq in
6. 3 sq in

Self-Test Exercises

Answer the following questions and problems. Check your answers with those in the Appendix. If you answer less than 7 items correctly, repeat your work in this chapter. If you answer 7 or 8 correctly, you have mastered the application of formulas and tables in solving work-related problems. Take the Posttest that is contained in the Appendix.

Write formulas to represent the relationships in questions 1 and 2.

1. The number of centimeters equals the number of inches times 2.5.
2. The discount price of a product is equal to the regular price minus the product of the regular price times the percent discounted divided by 100.
3. The circumference of a metal disk is equal to the diameter times the value pi (π). This is written:

$$C = \pi \times D$$

π is always equal to 3.14. Find the circumference of the disk when D = 4.5 inches.

4. A plumber has an appointment to install new fixtures in a house located 35 miles away. The formula for calculating travel time is

$$T = \frac{D}{R}$$

where D is the distance travelled and R is the rate of speed. How long should the plumber allow for travel time (going and coming) if he can drive 55 miles per hour?

5. The amount of profit you can make on a job equals the price charged minus the cost of doing the job. How much profit would you make if you charged $475 for a job that cost you $387.49?

6. The tempering temperature for hammer faces is 232° Celsius (C). To measure that temperature using a Fahrenheit (F) thermometer you would need to convert the degrees C to F. Use the table in Figure 28 to find the temperature in Fahrenheit.

Temperature Conversion Table

C°	°F
224	435
226	438
228	442
230	445
232	449
234	453
236	456
238	460

Figure 28

Figure 29 shows the size of bits needed to drill shank holes and pilot holes for different screw sizes. Use it to answer questions 7 and 8.

7. What size bit would you need to drill a shank hole for a size 6 screw?

8. What size bit would be needed to drill a pilot hole in hardwood for a number 3 screw?

Drill Bit Sizes

Screw Size	For Shank Hole	For Pilot Hole	
		Softwood	Hardwood
0	1/16	1/64	1/32
1	5/64	1/32	1/32
2	3/32	1/32	3/64
3	7/64	3/64	1/16
4	7/64	3/64	1/16
5	1/8	1/16	5/64
6	9/64	1/16	5/64

Figure 29

5. Appendix

Answers To Pretest

1. 1 : ten thousands
   4 : thousands
   7 : hundreds
   2 : tens
   5 : ones
2. 15564
3. 24793
4. 25′
5. 12′
6. 4 (26 lengths can be cut per rod)
7. $293
8. 2304 square feet
9. 35.369 mm.
10. 16-19/24 oz.
11. 18
12. $115.50
13. $308.00
14. 5.625″
15. 4-7/12″
16. ⅞ in.
17. $D = V \times T$
18. $P = 2 \times L + 2 \times W$
19. 5.5
20. 44.16 square inches
21. 77 degrees fahrenheit
22. May

Answers To Self-Test Exercises

Chapter 2: Arithmetic Operations

1.

Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
7	6	5	4	3	2	1

– You should have identified these place values

2. Find your digit in Column A. Check your Answer in Column B.

Column A *If the digit in your ones column was:*	**Column B** *You would have to add the following to increase the tens column by 1*
0	10
1	9
2	8
3	7
4	6
5	5
6	4
7	3
8	2
9	1

The value in the ones column would be zero. For example:

```
   1  – Carry
7863284
    + 6
-------
7863290
```

3. Dimension A = 61″:

```
  4
  9        Using multiplication:
  8
 27                    2
  9       9 × 2 =     18
 +8       8 × 2 =   + 16
 --                  ---
 61                   61
```

4. To find out the length of Slot B, you would subtract out 17″ and 22″ from the length of Dimension A:

```
  17                5
+ 22              61
 --             - 17
 39               --
                  44
      -or-
   5
  61              44
- 39            - 22
 --              ---
 22″             22″
```

5. The number of miles he would drive this year would equal the miles per week times the weeks per year:

```
  23
 247
×  50
 ---
 000
1235
----
```

12,350 miles

6. Gallons of gas would equal the miles driven divided by the average miles per gallon:

```
   726 gallons
17)12350
   119
   ---
    45
    34
   ---
   110
   102
   ---
     8
```

Since we are estimating, we don't worry about the remainder.

7. The cost of gas this year equals the number of gallons times the cost per gallon:

```
 25 ←
 13 ← Carries
  726
×  95
 ----
 3630
6534
-----
68970¢
```

or in dollars

```
$ 689
100)68970
   600
   ---
   897
   800
   ---
   970
   900
   ---
    70
```

8. **Yes.** One way she could cut the lengths would be:

	Scrap
1. 3 - 32″ lengths = 96″	0
2. 1 - 72″ + 2 - 12″ = 96″	0
3. 1 - 72″ + 2 - 12″ = 96″	0
4. 1 - 72″ + 1 - 18″ = 90″	6″
5. 1 - 40″ + 3 - 18″ = 90″	2″
6. 2 - 40″ + 1 - 12″ = 92″	4″

Chapter 3: Fractions

1. A is equal to the total width minus the sum of the other dimensions. The LCD is 48:

$\frac{3}{16} = \frac{9}{48}$ $\frac{1}{4} = \frac{12}{48}$

$\frac{3}{8} = \frac{18}{48}$ $1\frac{1}{3} = \frac{64}{48}$

$\frac{6 + 12 + 18}{48} = \frac{36}{48}$ (sum of dimensions)

$\frac{64}{48} - \frac{36}{48} = \frac{28}{48}$ (which reduces to $\frac{7}{12}$″)

2.

$$\begin{array}{r} .5833 \\ 12\overline{)7.0000} \\ 60 \\ \hline 100 \\ 96 \\ \hline 40 \\ 36 \\ \hline 40 \\ 36 \\ \hline \end{array}$$

$7/12" = .583"$

3. $\frac{7}{12} \times \frac{1}{\cancel{3}_{1}} = \frac{7}{18}"$
$\cancel{6}_{2}$

4. A ⅔ reduction would be about **67%** of full-size. (Determined by dividing 2 by 3 and rounding it to the nearest percent).

5. Cost of bags = $3.99 × 12 =

	47.88
	8.50
	3.98
	8.79
+	5.65

Total cost **$74.80**

6. $\begin{array}{r} \$\ 8.50 \\ \times\ .20 \\ \hline \$1.7000 \end{array}$ The discount is $1.70, so the reduced price is $8.50 − 1.70 = **$6.80**

7. The number of settings equals the total inches divided by the inches per setting:

$$\begin{array}{r} 13. \text{ settings} \\ .175\overline{)2.275} \\ 175 \\ \hline 525 \\ 525 \\ \hline \end{array}$$

8. Since the planks overlap by ½", the total space covered by each plank would be 5-¾" − ½" = 5-¼". The number of planks equals the total height of the wall divided by the space covered by each plank:

$$96 \div 5\text{-}\tfrac{1}{4} = \frac{96}{1} \div \frac{21}{4} = \frac{\overset{32}{\cancel{96}}}{1} \times \frac{4}{\underset{7}{\cancel{21}}} = \frac{128}{7} =$$

$18\text{-}\frac{2}{7}$

19 planks would be needed.

Chapter 4: Formulas and Tables

1. **C = 2.5 × I** (you could have used different letters to represent centimeters and inches, for example: cm = 2.5 × in)

2. **DP = RP − (RP × D/100).**
DP = Discount price
RP = Regular price
D = Discount

3. C = π D
C = 3.14 × 4.5
C = 14.13 inches

4. The total distance (D) coming and going is equal to 2 × 35 or 70 miles. The rate (R) equals 55 miles per hour.
T = D/R
T = 70/55
T = 1.27 hours

5. P = Pr − C
P = $475 − $387.49
P = $87.51

6. **449°F**

7. 9/64

8. 1/16

Posttest

Directions: *Answer the following questions. Place your answers in the space provided or use a separate sheet to perform your calculations and record your answers. After completing all of the questions, check your answers with the answers that follow. If you score 80% or better, you have successfully completed Basic Mathematics. If you score less than 80%, repeat the portions of the module with which you had difficulty.*

For questions 1-5 indicate the arithmetic operation you would use to solve the problem:

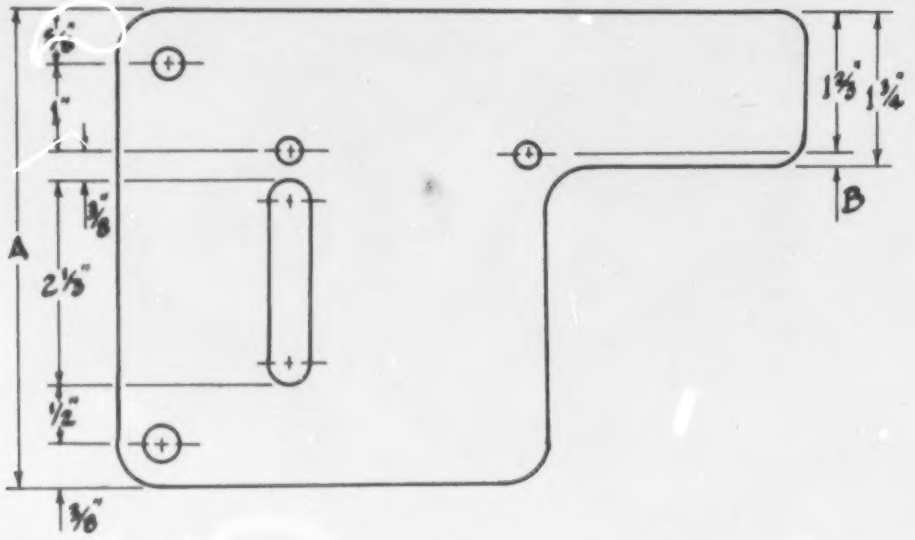
a. Addition
b. Subtraction
c. Multiplication
d. Division

1. A machinist produces 317 parts in an eight hour day. How would you determine the machinist's average production for one hour? _____
2. Fabric costs $4.97 per yard. How would you determine the price for 23 yards of fabric required for a job? _____
3. An apprentice is to weld six lengths of iron rod of varying sizes end to end. How would the apprentice determine the length of the finished product? _____
4. If the six rods in question 3 were equal in length, how would the apprentice determine the total length? _____
5. A mason contractor writes a check for $1,078.49 for supplies. How would the mason determine the balance of the checking account? _____
6. An apprentice is instructed to buy wallpaper for a room with the following wall areas:

   East Wall: 72 square feet
   West Wall: 72 square feet
   North Wall: 96 square feet
   South Wall: 96 square feet

   Windows took up 32 square feet of space that would not need papering. How many square feet of wallpaper would be needed for the room?
7. A contractor is building a subdivision of homes, 13 of which will have the same wallpaper requirements as the room in question 6. How much paper will be needed for all 13 houses?
8. How many rows of corn can be planted in a 576 foot wide field if the rows are planted about 3 feet apart?
9. Solve the problem in question 2.
10. How would the measurement 12.75″ be written as a common fraction?
11. A pipefitter needs 24 sections of ⅝″ pipe, each measuring 14-½″ in length. The pipe can be purchased in 96″ lengths. How many 96″ lengths will the pipefitter need to buy?
12. Of 438 parts produced in a day, 28 were rejects. What percent of the daily production were rejects? Round your answer to the nearest hundredth.

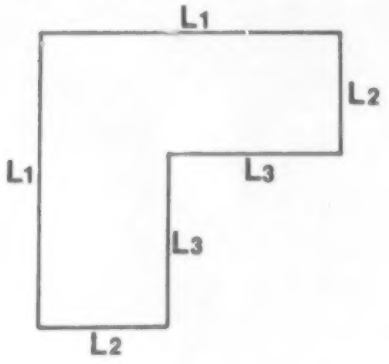
13. What is the length of dimension A in the figure below?
14. What is the length of dimension B in the figure below?



15. Cost of weekly supplies are listed below. What is the total cost for the week's supplies?

$249.59
10.00
17.49
2.29
2.29
87.64

16. If State tax on the supplies listed above is 5%, how much tax would be paid on the week's supplies?
17. Write a formula to represent the distance around the figure pictured below:



18. Write a formula for the following rule:

    Degrees Fahrenheit is equal to ⅘ times degrees Celsius, plus 32.

19. Determine the Fahrenheit equivalent of 30° Celsius.

20. One gallon is equal to 3.79 liters (l = 3.79 × G). How many liters can fit in a 50 gallon drum.

21. An apprentice's gross wages for one month are $937.48. How much income tax should be withheld from the employee's check if the number of allowances claimed is 3. Use the table below.

Single Persons—Monthly Payroll Period

Wages		Number of Withholding Allowances Claimed					
At Least	Less Than	0	1	2	3	4	5
		Income Tax Withheld					
840	880	117.70	101.00	86.30	72.90	59.60	46.30
880	920	125.70	109.00	92.70	79.30	66.00	52.70
920	960	133.70	117.00	100.30	85.70	72.40	59.10
960	1000	141.70	125.00	108.30	92.10	78.80	65.50
1000	1040	149.70	133.00	116.30	99.70	85.20	71.90
1040	1080	158.40	141.00	124.30	107.70	91.60	78.30

22. If your employer withheld $133.00 in income tax from your check, what were your approximate wages and the number of allowances claimed? Use the table above.

Answers To Posttest

1. d. Division
2. c. Multiplication
3. a. Addition
4. c. Multiplication
5. b. Subtraction
6. 304 sq. ft.
7. 3952 sq. ft.
8. 192 rows
9. $114.31
10. 12-¾"
11. 4
12. 6.39%
13. 5-5/24"
14. 1/12"
15. $369.30
16. $18.47
17. $2\times L_1 + 2\times L_2 + 2\times L_3$
18. °F = 9/5 °C + 32
19. 86° F
20. 189.5 liters
21. $85.70
22. Wages range from $1000-1040
    Allowances claimed is 1

Items 1-8 test material covered in Chapter 2, items 9-16 test material in Chapter 3 and items 17-22 test material in Chapter 4.